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MECHANICAL PROPERTIES, INCLUDING FRACTURE TOUGHNESS AND FATIGUE, CORROSION CHARACTERISTICS AND FATIGUE-CRACK PROPAGATION RATES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS

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Contract No. F33615-68-C-1385
Project No. 7381
Fifth Technical Management Report
February 15, 1969 - May 15, 1969

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ABSTRACT

The tensile, compressive, shear and bearing properties
~~were~~ have been determined for all of the 2014-T652, 2024-T852,
7075-T7352 and 7079-T652 hand forgings being investigated. The
property values and the ratios among these properties are
reported. All of the tensile and compressive stress-strain
tests, including modulus determinations, ~~were~~ have been made. The
results of the individual notch-bend fracture toughness tests
are reported. All of the remaining axial-stress fatigue tests
of smooth specimens were completed. (1)

The current status of the stress-corrosion tests is
presented. Performance of the 2024-T852 and 7075-T7352 forgings
~~was~~ has, in general, been typical of that expected for these alloy-
temper combinations. Accelerated exfoliation tests of specimens
from the 6x24-in. hand forgings displayed excellent resistance
to exfoliation, and there was no significant difference between
alloys. The fatigue crack propagation tests of the 2014-T652
specimens have been completed. The effects of notch geometry,
specimen length and change of the load during testing are
reported.

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Fifth Technical Management Report

MECHANICAL PROPERTIES, INCLUDING FRACTURE TOUGHNESS AND FATIGUE, CORROSION CHARACTERISTICS AND FATIGUE-CRACK-PROPAGATION RATES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS

I. Introduction.

The design mechanical properties, fracture toughness, corrosion characteristics and fatigue-crack propagation rates are four of the most important factors involved in the selection and efficient design of aircraft structures. Such data are needed for aluminum alloy hand forgings for several reasons:

(1) much of the published design data has become obsolete by a change in the basis of specifying minimum properties, from one in which the length, width and thickness were considered, to one where only the thickness is involved; (2) the development of a technique of stress relief by cold work in compression has resulted in relatively new tempers (TX52) for many of the alloys; and (3) there have been some significant problems with forged parts in recent years that were related to fracture and stress-corrosion characteristics.

Accordingly, the properties of hand forgings of several aluminum alloys currently being used in aircraft structures are being determined under this contract. The tests are intended to provide statistically reliable data for deriving design mechanical properties for MIL-HDBK-5A, including stress-strain and compressive tangent-modulus curves. In

addition, data concerning the fracture toughness, axial-stress fatigue, stress-corrosion, exfoliation and fatigue-crack propagation rates are being obtained.

This Fifth Technical Management Report summarizes the results of tests carried out during the fifth quarter of the contract, and the general status of the program at this time.

II. Material.

As previously reported in the Fourth Technical Management Report, all of the hand forging samples to be investigated have been received. They meet the applicable composition and tensile property requirements specified in Federal Specification QQ-A-367g and the Aluminum Association, "Aluminum Standards and Data," April 1968.

III. Procedure.

The specimens and test procedures being used are essentially the same as described in the First Technical Management Report, dated May 15, 1968.

IV. Progress During Quarter.

A. Mechanical Properties

A.1. Tensile, Compressive, Shear and Bearing

The remaining tensile, compressive, shear and bearing tests were completed during the quarter. The results of all the tests are summarized in Tables I through IV. The tensile properties of each sample exceed the specified minimum values

shown in Table V. Ratios among the properties of the individual samples are shown in Table VI. These ratio values have been submitted for statistical analyses.

All of the individual tensile and compressive stress-strain tests, including modulus determinations, have been made. These data are now being analyzed for preparation of typical and minimum curves which will be presented in the final report; average modulus values will also be determined.

A.2. Fracture Toughness

Notch-bend fracture toughness tests were made of all the samples scheduled for test. The test results for all but twelve of the individual specimens tested are shown in Table VII. Although some of the reported values are not strictly valid by all the criteria of the ASTM Recommended Method of Test for Plane-Strain Fracture Toughness of Metallic Materials, most of the calculated K_Q values are considered to be meaningful values of K_{Ic} . As may be noted, in most cases the stress intensity used in fatigue cracking was only slightly in excess of 50 per cent of the K_{Ic} or the fatigue crack front deviated from straightness by slightly more than 5 per cent. Retests are now being made in the twelve cases where the values obtained in the original tests were invalid because (1) the stress intensity used in fatigue cracking was definitely too high, (2) there was excessive yielding before crack propagation, or (3) because of excessive crack front deviation.

A.3. Axial-Stress Fatigue

All of the remaining axial-stress fatigue tests of smooth long-transverse specimens have been completed. The data for all of the tests are summarized in Table VIII and the results of the tests completed during this quarter (7075-T7352) are plotted in Fig. 1.

In general, the log-mean fatigue life values of the respective hand forging alloys are about the same or slightly higher than those of extrusions tested in a previous contract, AF33(615)-3580, and slightly lower than those of plate tested in previous contracts AF33(657)-11155 and AF33(615)-2012.

B. Corrosion Characteristics

B.1. Resistance to Stress-Corrosion Cracking

Stress-corrosion tests of short-transverse specimens from the 2x8, 3x12 and 5x20-in. hand forgings were completed during this quarter. Tests of longitudinal and long-transverse specimens from these forgings are continuing, and have now been in progress for 164 days.

All of the stress-corrosion test specimens from the 4x16-in. and 6x24-in. forgings were exposed to the 3.5% NaCl alternate-immersion test during the quarter.

The current status of stress-corrosion tests of longitudinal and long-transverse specimens is given in Table IX, and of the short-transverse specimens in Table X.

Thus far, no longitudinal test specimen has failed. While tests of the 4 and 6-in. thick forgings have progressed

For only short periods, tests of specimens from the 2-in. thick forgings have nearly completed the 182-day exposure without failure, thereby confirming the expected high resistance of all alloy-temper combinations in this direction.

Long-transverse failures have occurred only with 2014-T652 and 7079-T652 specimens stressed at 75% of the tensile yield strength. Representative failures were examined microscopically and the mode of failure was confirmed as stress-corrosion cracking.

The results of tests of short-transverse specimens from the 2, 3 and 5-in. thick forgings were considered in the Fourth Technical Management Report, and it was observed that the performance of the 2014-T652 and 7079-T652 materials was better than that typically seen for these alloys. The performance was within the bounds of existing stress-corrosion data for the alloys, however, and therefore wasn't questioned at that time. Subsequent test results for the 4 and 6-in. forgings revealed more typical performance (see following paragraphs), however. Since the 2-in. thick forgings would be expected to show an even greater susceptibility to stress-corrosion cracking than the 4 and 6-in. thick material, specimens are being obtained for retests to verify the test results for the 2-in. thick 2014-T652 and 7079-T652 forgings.

Tests of short-transverse specimens from the 4-in. thick forgings have progressed for a period of 48 days, and the results are in agreement with expected performance of the

Fifth Technical Management Report

MECHANICAL PROPERTIES, INCLUDING FRACTURE TOUGHNESS AND FATIGUE, CORROSION CHARACTERISTICS AND FATIGUE-CRACK-PROPAGATION RATES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS

I. Introduction.

The design mechanical properties, fracture toughness, corrosion characteristics and fatigue-crack propagation rates are four of the most important factors involved in the selection and efficient design of aircraft structures. Such data are needed for aluminum alloy hand forgings for several reasons: (1) much of the published design data has become obsolete by a change in the basis of specifying minimum properties, from one in which the length, width and thickness were considered, to one where only the thickness is involved; (2) the development of a technique of stress relief by cold work in compression has resulted in relatively new tempers (TX52) for many of the alloys; and (3) there have been some significant problems with forged parts in recent years that were related to fracture and stress-corrosion characteristics.

Accordingly, the properties of hand forgings of several aluminum alloys currently being used in aircraft structures are being determined under this contract. The tests are intended to provide statistically reliable data for deriving design mechanical properties for MIL-HDBK-5A, including stress-strain and compressive tangent-modulus curves. In

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crack growth rates were determined from the slopes of the crack propagation curves.

Figs. 6 and 7 show the data for the 24-in. long specimens (sharp notch) whose tests were started at a maximum gross stress of 8.2 ksi. Cracks were not visible at all four corners of the notch of specimen 14 until the total crack length was beyond 0.5 in.; specimens with this great an eccentricity are excluded from the discussion. The humidity appears to have affected the rate of propagation of the specimens stressed to this level; specimens 18 and 20, which were tested under the most humid conditions, had the highest rates of propagation. There does not seem to be such a correlation in Figs. 8 and 9 for specimens initially stressed to 12.5 ksi. Crack initiation was more uniform at the higher stress.

C.1. Notch Shape

The crack growth data for the specimens having the two shapes of 0.5-in. long machined notches (Figs. 20 and 21) are presented in Figs. 2 and 4 and the crack growth rates in Figs. 3 and 5. The crack growth rates for the mild-notched specimens (Fig. 20) are generally within the range of those of the sharp-notched specimens (Fig. 21). Even eliminating particularly eccentrically-cracked specimens such as mild-notch specimen No. 4 from consideration, there was more scatter in the results shown for duplicate specimens than was shown for specimens having the sharp notches. The fracture surfaces of mild-notched specimens 7 and 10, which showed a large difference in crack growth rate,

were visually different as were those of the adjacent sharp-notched specimens 8 and 11. Cross-sections of the surfaces of specimens 7 and 10 are shown in Fig. 23. Specimen 7 has a directional or fibrous type structure in the fractured region whereas the faster propagating specimen 10 shows a coarse, non-fibrous structure. These specimens were taken at locations about 3 in. apart from the same central portion of the cross-section.

The most eccentric cracking was obtained for specimens having the mild notch. However, few specimens having either notch had as uniform crack initiation as desired. As reported in the Fourth Technical Management Report, crack initiation was somewhat more uniform for 7178-T651 specimens having a thin elox notch. In general, it does not appear that the crack growth is significantly different for the specimens having mild or sharp notches.

C.2. Specimen Length

The results for specimens tested to determine the effect of length of test section are plotted in Figs. 10 through 13. At a stress of 8.2 ksi, the results for the short (6-in.) specimens are generally within the range of the results for the long (24-in.) ones. At a stress of 12.5 ksi, the rate of crack growth of 6-in. long specimen 9 was somewhat lower for cracks beyond 1/2 in. than those of any of the three 24-in. long specimens having the similar sharp notches. However, propagation was not as slow as shown in Fig. 5 for specimen 7 having a mild

notch. Thus, it appears that the short specimens will be suitable for evaluating the crack propagation behavior for short-transverse specimens.

C.3. Change in Load

Figs. 14 and 15 present the data for all specimens for which loads were changed when the crack length reached 0.5 in. Thus, in Fig. 14, there is a new zero cycle origin at a notch plus crack length of 1 in. (33.3%). The crack growth rates of specimens 16 and 19 after the reduction in load correlate well with the plots for their initial loading at 12.5 ksi. For specimen 13, however, the growth at this reduced load is substantially slower up to a ΔK of about 10.5. The crack growth of this specimen during its loading to 12.5 ksi had also been slower than that of any other specimen stressed to that level so its slow propagation at 8.2 ksi does not appear to be a result of the higher loading.

In Figs. 16 and 17, the crack propagation results for the specimen whose gross stresses were reduced from 12.5 to 8.2 ksi after the crack length reached 0.5 in. are compared with the plots of specimens tested entirely at 8.2 ksi. Although it is not shown, a "rest" period of no propagation occurs when the load is reduced. When propagation resumed, crack growth was slower for specimen 13 and faster for specimen 19 than was found for any specimens tested entirely at 8.2 ksi. However, the general slopes for the crack growth rate plots are similar for the two methods of test.

Figs. 18 and 19 show the results of the tests in which the cracks were developed to 0.5 in. at 8.2 ksi and then propagated to failure at 12.5 ksi. Generally, the propagation at the low stress does not appear to have affected the rate of propagation at the higher stress.

The data indicate that the test loads can be raised or lowered between the levels of 8.2 and 12.5 without significantly affecting subsequent propagation. The reduction in load procedure would appear to be more practical than the increase in load. However, for the method to be worthwhile, it is necessary that it be possible to extrapolate the rate of crack growth to lower or higher values of ΔK . Judging from the data for specimens tested entirely at one load level, extrapolation of the data would not be reliable. This may be a result of the eccentric cracking. If the revised test method described below does produce uniform cracking, some specimens of the other alloys may be tested using a reduction of load method.

Tests of specimens of alloys 2024-T852 and 7079-T652 have been started. In order to obtain more uniform cracking than was found for the 2014-T652 specimens, cracks are being initiated at the ends of a 0.20-in. long elox notch (Fig. 22) using a load cycle of 0 to 12.5 ksi gross stress. When cracks are visible at all four corners of the notch the load is adjusted to the desired level and the crack propagated to 0.5 in. The test is considered to start at this point. For the first two specimens, this has produced uniform crack lengths.

V. Summary.

All of the tensile, compressive, shear and bearing tests have now been completed and the test results are shown in Tables I through IV. The tensile properties of the samples meet the applicable minimum-property requirements shown in Table V. The ratios among the properties are summarized in Table VI; they have been submitted for statistical analyses.

All of the tensile and compressive stress-strain tests, including modulus determinations, have been made. The test data are being computed and analyzed.

Notch-bend fracture-toughness tests were made of all the samples scheduled for test. The results of the individual tests are presented in Table VII for all but four groups of specimens whose K_{Ic} values were considered invalid for reasons related to unsatisfactory precracking of the specimens; retests are now in progress.

The remaining axial-stress fatigue tests were completed. The results of the tests are shown in Table VIII and plotted in Fig. 1.

The current status of stress-corrosion tests is given in Tables IX and X. Some disparity was noted in the performance of 2014-T652 and 7079-T652 forgings, with the 4 and 6-in. thick forgings showing a greater (but still typical) susceptibility to stress-corrosion cracking than the 2-in. forgings. Specimens are being obtained for retests to verify the performance of the 2-in. forgings. The performance of the 2024-T852 and 7075-T7352

forgings has generally been typical of that expected for these alloy-temper combinations.

The fatigue-crack propagation tests of the 2014-T652 specimens have been completed. The tests (long-transverse specimens) showed that (1) the use of a sharper notch than was used in previous investigations did not appear to alter the crack propagation behavior significantly, (2) the 6-in. long specimens (which will be used for short-transverse tests of 2024-T852 and 7075-T7352) gave essentially the same rates of propagation as the 24-in. long specimens, and (3) when the load was changed, the rate of propagation was not affected by the previous loading.

Crack propagation tests of 2024-T852 and 7079-T652 specimens have been initiated. Use of a 0.20-in. long elox notch instead of a 0.50-in. machined notch and crack initiation at a higher stress have produced more uniform cracking in the first several specimens. The 7075-T7352 specimens are also being elox notched.

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VI. Tables and Figures.

TABLE I

MECHANICAL PROPERTIES OF STRESS-RELIEVED 2014-T652 ALUMINUM ALLOY HOLLOW FORGINGS
 (F33615-68-C-1385)

SAMPLE	CROSS-SECTIONAL NUMBER	DIRECTIONS IN.	TENSILE			COMP.	SHEAR	BEARING:		
			ULT. STRESS. PSI	YIELD STRESS.* PSI	ELONG. IN 2 IN. OR 40. %			ULT. STRESS. PSI	YIELD STRESS. PSI	ULT. STRESS. PSI
2X 8	341007	L	71 600	66 500	11.5	30	69 200	44 200	101 000	122 500
		LT	71 700	64 900	6.0	9	70 300	43 600	101 000	130 100
		ST	66 400	61 400	9.4	34	68 700	—	—	—
3X12	341008	L	71 800	66 200	10.5	28	68 400	42 200	102 300	132 500
		LT	71 000	65 100	7.5	12	69 600	41 800	97 100	126 800
		ST	69 700	62 200	5.0	7	69 700	41 300	—	—
4X 8	341009	L	70 300	64 200	12.5	29	66 400	40 400	89 300	123 700
		LT	69 900	63 600	7.5	12	65 100	40 600	90 700	121 700
		ST	66 500	59 500	11.5	4	69 300	39 900	—	—
4X16	341010	L	69 100	62 500	11.5	26	61 400	38 700	106 800	123 900
		LT	66 600	59 200	6.0	8	61 500	38 800	101 900	114 900
		ST	65 800	57 000	6.0	6	61 900	38 900	—	—
5X 5	341011	L	68 600	63 200	12.0	28	65 300	41 800	88 200	117 300
		LT	67 500	61 200	4.0	5	62 500	40 700	87 200	118 400
		ST	65 200	58 800	2.0	4	66 500	41 200	—	—
5X10	341012	L	68 800	61 600	11.5	27	63 000	40 600	93 400	117 400
		LT	67 300	60 200	5.5	9	61 700	40 300	88 700	123 400
		ST	64 600	57 400	3.0	6	65 300	38 700	—	—
5X20	341013	L	68 500	60 700	11.5	24	61 200	38 800	90 100	113 500
		LT	64 700	57 300	5.0	7	63 500	38 400	86 600	117 500
		ST	63 900	56 100	3.7	7	62 800	37 300	—	—
6X 6	341014	L	67 700	62 000	12.0	31	64 000	42 400	97 400	114 200
		LT	64 900	59 500	3.5	5	60 400	40 700	89 300	121 100
		ST	64 200	55 900	2.8	1	65 700	40 500	—	—
6X12	341015	L	66 200	59 500	11.0	27	60 300	40 200	91 100	120 100
		LT	64 200	58 400	3.5	6	61 900	38 800	87 700	119 000
		ST	63 900	55 000	3.5	2	61 900	38 700	—	—
6X24	341016	L	66 600	55 900	9.5	19	57 900	42 500	89 500	118 100
		LT	66 600	57 700	6.0	6	62 400	38 800	86 300	117 900
		ST	62 600	54 000	6.0	14	59 300	39 000	—	—

* OFFSET EQUALS 0.2 PER CENT

† OFFSET EQUALS 2 PER CENT OF PIN DIAMETER

‡ SPECIMENS AND FIXTURES CLEANED ULTRASONICALLY

§ L = LONGITUDINAL; LT = LONG TRANSVERSE; ST = SHORT TRANSVERSE

Table I

TABLE II

**MECHANICAL PROPERTIES OF STRESS-RELIEVED 2024-T852 ALUMINUM ALLOY HAND FORGINGS
(F33615-68-C-1385)**

SAMPLE	CROSS-SECTIONAL NUMBER	DIRECTIONS IN.	TENSILE			COMP.	SHEAR	BEARING: EDGEWISE		
			ULT. STRESS, PSI	YIELD STRESS,* PSI	ELONG. IN 2 IN. OR 4D. %			ULT. STRESS, PSI	ULT. STRESS, PSI	e/D=2.0
2x 6	341017	L	70 800	64 600	7.0	28	70 200	42 700	97 700	133 100
		LT	72 300	63 800	9.0	17	72 700	41 800	94 500	125 900
		ST	67 400	64 000	1.6	3	74 600	—	—	—
3x12	341018	L	72 200	66 700	5.5	18	70 000	42 400	94 900	123 400
		LT	73 700	69 000	3.0	2	75 800	42 000	94 500	126 100
		ST	68 100	64 400	1.0	2	72 200	40 200	—	—
4x 6	341019	L	68 900	61 100	9.0	26	62 200	40 500	91 900	117 900
		LT	70 400	63 200	5.0	8	63 500	39 500	88 800	119 400
		ST	65 700	57 200	3.2	4	65 500	38 600	—	—
4x16	341020	L	71 400	65 400	6.5	23	66 600	41 100	92 100	124 000
		LT	71 000	65 200	5.0	8	71 500	40 200	91 500	127 100
		ST	70 100	60 600	2.4	6	70 200	39 900	—	—
5x 5	341021	L	69 000	62 000	8.5	29	63 400	40 800	93 500	125 200
		LT	68 400	62 100	3.0	1	63 100	40 700	89 100	121 600
		ST	66 500	56 000	2.8	4	64 700	39 600	—	—
5x10	341022	L	68 400	61 000	8.5	25	63 000	40 300	89 100	114 300
		LT	69 100	61 500	6.0	8	64 800	39 700	89 500	120 200
		ST	66 100	59 800	1.5	4	68 400	38 800	—	—
5x20	341023	L	65 200	55 100	9.0	16	57 800	38 600	63 600	112 600
		LT	62 800	56 700	3.0	4	60 700	38 000	84 900	114 600
		ST	63 200	54 500	3.0	3	59 400	37 000	—	—
6x 6	341024	L	69 100	61 600	9.0	28	63 700	41 500	95 300	123 900
		LT	68 800	60 600	6.5	10	61 500	40 600	92 000	123 200
		ST	69 400	58 500	2.3	3	67 600	39 000	—	—
6x12	341025	L	67 000	58 700	8.0	22	59 700	39 600	84 700	117 100
		LT	67 400	60 200	3.2	4	63 500	38 400	85 700	113 400
		ST	65 300	55 100	2.9	3	63 000	37 400	—	—
6x24	341026	L	64 300	56 100	7.5	20	56 000	37 100	80 900	111 700
		LT	65 400	57 800	5.0	8	57 500	36 100	84 300	98 600
		ST	58 000	53 900	1.0	1	58 000	34 900	—	—

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+ OFFSET EQUALS 2 PER CENT OF PIN DIAMETER

: SPECIMENS AND FIXTURES CLEANED ULTRASONICALLY

§ L = LONGITUDINAL; LT = LONG TRANSVERSE; ST = SHORT TRANSVERSE

Table II

Table III

MECHANICAL PROPERTIES OF STRESS-RELIEVED 7075-T7352 ALUMINUM ALLOY HAND FORGINGS
(F33615-68-C-1385)

TABLE III

SAMPLE	CROSS-SECTIONAL NUMBER DIRECTIONS, IN.	TENSILE			COMP.		SHEAR		BEARING \pm EDGEWISE			
		ULT. STRESS., PSI	YIELD STRESS*, PSI	ELONG. OR 4D. %	RED. OF AREA, %	YIELD STRESS*, PSI	ULT. STRESS., PSI	e/D=1.5	e/D=2.0	ULT. STRESS., PSI	e/D=1.5	e/D=2.0
2X 8	341027 L	73 700	65 300	13.5	43	69 300	46 800	111 900	147 200	93 700	111 200	92 700
	LT	74 900	65 300	13.5	29	68 800	44 500	110 600	146 300	—	106 500	—
	ST	73 100	61 800	6.3	9	69 300	—	—	—	—	—	—
3X12	341028 L	76 400	66 200	11.5	27	66 900	42 400	103 100	136 100	89 000	103 800	89 800
	LT	71 400	59 300	8.0	11	65 300	42 600	98 300	135 100	—	110 300	—
	ST	73 000	60 800	4.2	5	69 300	42 900	—	—	—	—	—
4X 8	341029 L	68 400	57 300	15.0	42	60 200	39 800	95 100	130 000	83 500	98 600	—
	LT	65 100	53 000	10.0	17	57 600	38 400	98 500	127 100	81 400	97 000	—
	ST	64 500	50 600	6.4	10	57 500	38 200	—	—	—	—	—
4X16	341030 L	70 000	59 500	13.0	34	59 600	40 600	95 300	126 000	82 900	95 800	—
	LT	67 600	55 200	12.0	25	59 700	40 700	94 200	125 500	82 600	99 200	—
	ST	64 800	52 500	6.4	7	58 600	39 100	—	—	—	—	—
5X 5	341031 L	68 400	56 700	14.0	39	59 400	41 500	104 400	131 600	84 300	99 900	—
	LT	67 200	55 100	10.5	20	56 600	40 600	98 000	131 600	83 500	100 700	—
	ST	63 800	51 700	4.0	6	59 500	41 500	—	—	—	—	—
5X10	341032 L	65 200	52 700	14.0	37	53 400	39 600	95 900	124 600	82 300	91 900	—
	LT	64 000	51 400	9.0	17	53 800	38 500	97 700	127 100	80 100	97 000	—
	ST	64 200	49 500	7.0	9	58 000	39 400	—	—	—	—	—
5X20	341033 L	64 800	52 500	14.5	35	52 200	38 800	94 100	120 300	76 800	89 100	—
	LT	64 000	50 700	11.0	25	54 400	38 300	91 500	119 400	77 100	92 600	—
	ST	63 700	49 300	6.5	10	54 900	38 000	—	—	—	—	—
6X 6	341034 L	62 400	51 100	15.0	44	54 000	41 300	99 200	131 200	82 100	94 400	—
	LT	63 800	52 100	10.0	23	53 000	40 100	97 400	128 400	81 600	96 100	—
	ST	63 400	49 700	8.0	14	55 300	39 000	—	—	—	—	—
6X12	341035 L	63 300	52 600	12.5	34	50 300	39 800	98 700	123 700	80 000	94 600	—
	LT	63 400	50 900	9.0	14	51 200	38 600	95 000	123 700	79 400	95 000	—
	ST	60 800	49 800	6.5	9	54 400	37 400	—	—	—	—	—
6X24	341036 L	65 800	55 400	12.5	34	51 400	36 700	93 700	113 600	76 000	84 900	—
	LT	62 100	50 300	9.5	16	52 300	39 000	85 600	108 700	71 600	82 700	—
	ST	62 600	49 200	6.5	10	53 800	37 200	—	—	—	—	—

* OFFSET EQUALS 0.2 PER CENT

♦ OFFSET EQUALS 2 PER CENT OF PIN DIAMETER

‡ SPECIMENS AND FIXTURES CLEANED ULTRASONICALLY

§ L = LONGITUDINAL; LT = LONG TRANSVERSE; ST = SHORT TRANSVERSE

TABLE IV

MECHANICAL PROPERTIES OF STRESS-RELIEVED 7079-1652 ALUMINUM ALLOY HAND FORGINGS
(F333615-68-C-1385)

SAMPLE	CROSS-SECTIONAL NUMBER DIRECTIONS, IN.	TENSILE			COMP.	SHEAR	REFRACTING:				
		ULT. STRESS. PSI	YIELD STRESS. PSI	ELONG. IN 2 IN. OR 40. %			ULT. STRESS. PSI	ULT. STRESS. PSI	YIELD STRESS. PSI		
2x 8	341037	L	78 600	71 000	14.0	34	73 300	48 700	115 100	99 100	
		LT	76 100	64 900	12.0	20	73 200	46 500	114 500	98 000	
3x12	341038	L	77 500	68 700	13.0	26	71 300	46 400	113 200	96 800	
		LT	76 100	65 700	12.0	26	70 700	46 160	116 600	97 900	
4x 8	341039	L	78 800	69 600	11.0	21	72 800	48 900	111 600	99 400	
		LT	77 500	66 500	11.5	24	72 900	48 200	117 100	102 300	
4x16	341040	L	74 300	62 800	5.0	6	73 200	47 100	—	—	
		LT	77 900	63 000	12.0	22	70 100	46 600	113 000	95 200	
5x 5	341041	L	75 600	67 600	13.0	27	69 700	47 900	112 600	94 400	
		LT	72 900	63 000	8.5	12	67 000	45 900	105 200	143 600	
5x10	341042	L	71 300	59 500	7.0	10	66 400	46 300	—	—	
		LT	76 100	68 000	13.0	27	68 800	45 700	108 200	140 500	
5x20	341043	L	74 100	62 600	10.5	19	69 300	45 900	108 300	141 300	
		LT	73 000	61 300	5.5	5	72 200	44 400	—	—	
6x 6	341044	L	76 900	65 600	13.0	24	67 000	46 100	104 600	135 900	
		LT	73 300	61 400	11.0	19	65 700	46 400	103 300	136 900	
6x12	341045	L	73 600	63 800	15.0	37	68 900	48 400	112 200	148 100	
		LT	72 600	61 400	9.0	16	69 700	47 900	111 000	146 300	
6x24	341046	L	71 700	61 800	8.5	14	67 100	47 300	—	—	
		LT	75 200	65 700	11.0	25	67 500	46 300	109 000	139 300	
		ST	72 800	62 100	7.5	12	66 200	45 500	104 000	140 700	
		ST	72 400	58 800	6.0	7	69 300	44 700	—	—	
		ST	73 900	63 900	12.0	22	63 300	43 800	128 300	85 200	
		ST	69 100	57 500	10.0	22	62 900	42 000	87 700	123 300	
		ST	69 300	58 100	4.5	6	67 300	42 000	—	—	

* OFFSET EQUALS 0.2 PER CENT

† OFFSET EQUALS 2 PER CENT OF PIN DIAMETER

‡ SPECIMENS AND FIXTURES CLEANED ULTRASONICALLY

§ L. LONGITUDINAL; LT. LONG TRANSVERSE; ST. SHORT TRANSVERSE

Table IV

TABLE V

SPECIFIC CATION VALUES FOR ALUMINUM ALLOYS AND PORSESSES
(22771-80-333)

Alloy No. Number	Thickness, in.	Specific Cation Value		Specific Cation Value		Specific Cation Value		Specific Cation Value	
		Specific Cation Value							
2014-T52	Up thru 2.000 2.001-2.500 2.501-4.000 4.001-5.000 5.001-6.000	56 CCC 56 CCC 56 CCC 56 CCC 56 CCC							
2024-T52	All	---	---	---	---	---	---	---	None
7075-T752	Up thru 2.000 2.001-4.000 4.001-5.000 5.001-6.000	57 CCC 57 CCC 57 CCC 57 CCC							
7075-T52	Up thru 2.000 2.001-3.000 3.001-4.000 4.001-5.000 5.001-6.000	58 CCC 58 CCC 58 CCC 58 CCC 58 CCC							

* Offset equals 0.2 per cent.

** The Aluminum Association, "Aluminum Standards and Data," April 1966.
These values have been submitted for inclusion in a proposed revision C of
WELA-22771 and presented with this document for review.

Table V

Table VI

TABLE XI

RATIOS AMONG THE TENSILE, COMPRESSIVE, SMEAR AND BEARING PROPERTIES OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS

SAMPLE	CROSS SECT. SIZE. IN.			CYS(LT) TYS(LT)			CYS(SI) TYS(SI)			SS(LT) TS(LT)			SS(SI) TS(LT)			BS(LT) TS(LT)			BS(SI) TS(LT)			EDGEWISE BS(LT) TS(LT)						
	ALLOY AND TEMPER	0.62		0.61	0.59		0.58	0.58		0.57	0.66		0.63	0.46		0.65	0.38		0.36	0.37		0.36	0.30		0.28	0.37		0.36
		CROSS SECT. NUMBER	0.62	0.61	0.59	0.58	0.58	0.58	0.58	0.57	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
2014-7652	2X .6	341007	1.04	1.08	1.12	0.62	0.61	---	1.41	1.71	1.35	1.56	1.41	1.61	1.36	1.54	1.37	1.78	1.36	1.66	1.37	1.76	1.36	1.62	1.46	1.46	1.59	
	3X12	341008	1.03	1.07	1.12	0.59	0.58	0.58	1.44	1.87	1.38	1.65	1.30	1.76	1.28	1.62	1.53	1.73	1.53	1.75	1.50	1.74	1.50	1.68	1.55	1.55	2.0	
	4X .6	341009	1.03	1.03	1.17	0.56	0.56	0.58	1.28	1.77	1.36	1.63	1.30	1.76	1.28	1.62	1.53	1.73	1.53	1.75	1.50	1.74	1.50	1.68	1.55	1.55	2.0	
	4X16	341010	0.98	1.04	1.08	0.58	0.58	0.58	1.60	1.86	1.46	1.65	1.46	1.64	1.46	1.65	1.50	1.75	1.50	1.76	1.46	1.75	1.46	1.74	1.50	1.50	2.0	
	5X .5	341011	1.03	1.02	1.13	0.62	0.60	0.61	1.31	1.76	1.40	1.65	1.29	1.75	1.37	1.64	1.32	1.63	1.32	1.64	1.30	1.63	1.30	1.64	1.30	1.64	2.0	
	5X10	341012	1.02	1.02	1.14	0.60	0.60	0.57	1.39	1.74	1.37	1.57	1.32	1.63	1.37	1.62	1.32	1.63	1.32	1.64	1.30	1.63	1.30	1.64	1.30	1.64	2.0	
	5X20	341013	1.01	1.11	1.12	0.60	0.59	0.58	1.39	1.75	1.38	1.65	1.34	1.62	1.38	1.62	1.34	1.62	1.34	1.63	1.32	1.63	1.32	1.65	1.32	1.65	2.0	
	6X .6	341014	1.03	1.02	1.18	0.65	0.63	0.62	1.50	1.76	1.46	1.64	1.38	1.61	1.46	1.64	1.46	1.64	1.46	1.64	1.46	1.64	1.46	1.64	1.46	1.64	2.0	
	6X12	341015	1.01	1.06	1.12	0.63	0.60	0.60	1.42	1.87	1.40	1.64	1.37	1.65	1.42	1.64	1.37	1.65	1.37	1.65	1.35	1.65	1.35	1.65	1.35	1.65	2.0	
	6X24	341016	1.04	1.08	1.10	0.64	0.64	0.58	1.77	1.77	1.41	1.73	1.30	1.77	1.41	1.73	1.30	1.77	1.30	1.77	1.30	1.77	1.30	1.77	1.30	1.77	2.0	
2024-7652	2X .8	341017	1.09	1.14	1.17	0.59	0.58	---	1.35	1.86	1.50	1.82	1.31	1.74	1.35	1.65	1.31	1.74	1.31	1.74	1.31	1.74	1.31	1.74	1.31	1.74	1.31	
	3X12	341018	1.05	1.10	1.12	0.58	0.57	0.55	1.29	1.67	1.36	1.58	1.28	1.71	1.29	1.66	1.28	1.71	1.28	1.71	1.28	1.71	1.28	1.71	1.28	1.71	1.28	
	4X .8	341019	1.02	1.01	1.15	0.58	0.56	0.55	1.30	1.67	1.31	1.59	1.26	1.70	1.31	1.60	1.26	1.70	1.31	1.60	1.26	1.70	1.31	1.60	1.26	1.66	1.26	
	4X16	341020	1.02	1.10	1.16	0.56	0.56	0.57	1.30	1.74	1.34	1.61	1.29	1.79	1.34	1.61	1.29	1.79	1.34	1.61	1.29	1.79	1.34	1.61	1.29	1.66	1.29	
	5X .5	341021	1.02	1.02	1.15	0.60	0.59	0.58	1.37	1.83	1.45	1.69	1.30	1.78	1.45	1.69	1.30	1.78	1.30	1.78	1.30	1.78	1.30	1.78	1.30	1.78	1.30	
	5X10	341022	1.03	1.05	1.14	0.58	0.57	0.56	1.29	1.65	1.43	1.57	1.29	1.74	1.43	1.67	1.29	1.74	1.43	1.67	1.29	1.74	1.43	1.67	1.29	1.74	1.43	
	5X20	341023	1.05	1.07	1.09	0.62	0.61	0.59	1.33	1.79	1.40	1.67	1.35	1.83	1.40	1.67	1.35	1.83	1.40	1.67	1.35	1.83	1.40	1.67	1.35	1.83	1.40	
	6X .6	341024	1.03	1.01	1.16	0.60	0.59	0.57	1.39	1.80	1.40	1.69	1.34	1.79	1.40	1.69	1.34	1.79	1.40	1.69	1.34	1.79	1.40	1.69	1.34	1.79	1.40	
	6X12	341025	1.02	1.06	1.14	0.59	0.58	0.57	1.26	1.76	1.37	1.67	1.37	1.76	1.37	1.67	1.37	1.76	1.37	1.67	1.37	1.76	1.37	1.67	1.37	1.76	1.37	
	6X24	341026	1.00	0.99	1.08	0.57	0.55	0.55	1.24	1.71	1.39	1.64	1.29	1.79	1.39	1.64	1.29	1.79	1.39	1.64	1.29	1.79	1.39	1.64	1.29	1.79	1.39	
7075-77352	2X .8	341027	1.06	1.05	1.12	0.62	0.59	---	1.49	1.96	1.44	1.70	1.48	1.95	1.44	1.63	1.48	1.95	1.44	1.63	1.48	1.95	1.44	1.63	1.48	1.95	1.44	
	3X12	341028	1.01	1.10	1.14	0.59	0.60	0.60	1.44	1.91	1.50	1.75	1.38	1.89	1.50	1.66	1.38	1.89	1.50	1.66	1.38	1.89	1.50	1.66	1.38	1.89	1.50	
	4X .6	341029	1.05	1.09	1.14	0.61	0.59	0.59	1.46	1.90	1.50	1.73	1.39	1.87	1.50	1.65	1.39	1.87	1.50	1.65	1.39	1.87	1.50	1.65	1.39	1.87	1.50	
	5X .5	341030	1.00	1.08	1.12	0.60	0.60	0.58	1.41	1.86	1.50	1.73	1.39	1.86	1.50	1.64	1.39	1.86	1.50	1.64	1.39	1.86	1.50	1.64	1.39	1.86	1.50	
	5X10	341031	1.05	1.03	1.15	0.62	0.60	0.62	1.55	1.96	1.53	1.79	1.46	1.96	1.53	1.79	1.46	1.96	1.53	1.79	1.46	1.96	1.53	1.79	1.46	1.96	1.53	
	5X20	341032	1.01	1.05	1.17	0.62	0.61	0.62	1.50	1.95	1.50	1.79	1.46	1.95	1.50	1.79	1.46	1.95	1.50	1.79	1.46	1.95	1.50	1.79	1.46	1.95	1.50	
	6X .6	341033	1.00	1.07	1.11	0.61	0.60	0.59	1.47	1.88	1.51	1.76	1.47	1.88	1.51	1.76	1.47	1.88	1.51	1.76	1.47	1.88	1.51	1.76	1.47	1.88	1.51	
	6X12	341034	1.06	1.02	1.11	0.65	0.63	0.61	1.49	1.95	1.44	1.72	1.53	1.95	1.44	1.72	1.53	1.95	1.44	1.72	1.53	1.95	1.44	1.72	1.53	1.95	1.44	
	6X12	341035	1.01	1.09	1.12	0.63	0.61	0.59	1.56	1.95	1.51	1.86	1.56	1.95	1.51	1.86	1.56	1.95	1.51	1.86	1.56	1.95	1.51	1.86	1.56	1.95	1.51	
	6X24	341036	1.04	1.09	1.17	0.62	0.63	0.60	1.60	1.91	1.52	1.81	1.56	1.91	1.52	1.81	1.56	1.91	1.52	1.81	1.56	1.91	1.52	1.81	1.56	1.91	1.52	
7679-7652	2X .6	341037	1.03	1.13	1.17	0.64	0.61	---	1.51	2.03	1.53	1.76	1.50	1.96	1.50	1.75	1.50	1.96	1.50	1.75	1.50	1.96	1.50	1.75	1.50	1.96	1.50	
	3X12	341038	1.04	1.08	1.17	0.61	0.60	0.60	1.49	1.95	1.44	1.72	1.53	1.95	1.44	1.72	1.53	1.95	1.44	1.72	1.53	1.95	1.44	1.72	1.53	1.95	1.44	
	4X .8	341039	1.05	1.10	1.16	0.63	0.62	0.61	1.44	1.91	1.50	1.73	1.51	1.91	1.50	1.73	1.51	1.91	1.50	1.73	1.51	1.91	1.50	1.73	1.51	1.91	1.50	
	4X16	341040	1.03	1.06	1.12	0.62	0.61	0.60	1.60	1.96	1.52	1.81	1.56	1.96	1.52	1.81	1.56	1.96	1.52	1.81	1.56	1.96	1.52	1.81	1.56	1.96	1.52	
	5X .5	341041	1.01	1.06	1.15	0.66	0.65	0.64	1.54	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	
	5X10	341042	1.01	1.11	1.18	0.62	0.62	0.61	1.54	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	
	5X20	341043	1.02	1.07	1.17	0.63	0.63	0.63	1.54	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	
	6X .6	341044	1.08	1.09	1.14	0.67	0.66	0.66	1.54	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	
	6X12	341045	1.03	1.07	1.16	0.64	0.64	0.63	1.54	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	
	6X24	341046	1.09	1.09	1.14	0.64	0.64	0.63	1.54	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	1.84	1.56	1.96	1.53	

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Table VII

TABLE VII
RESULTS OF NOTCH-BEND FRACTURE TOUGHNESS TESTS
OF STRESS-RELIEVED ALLOYED ALUMINUM HARD FORGINGS
(P33615-68-C-1385)

Alloy and Temper	Sample Cross- Sect. Size, in.	Direction and Number	Specimen Type See Fig. 2	Specimen		Max. Load(lb), in.	Stress Intensity, Kips/in. Cycles	Length (a), in.	Crack Length (b), in.	At 5 Per Cent Seant Offset		Meaningful K _{IC} Fracture Appearance	
				First MPR	Width(y), in.					Load, K _Q , per/in. lb	Thickness, K _Q , per/in. 2.5($\frac{Q}{y}$) ² , in.		
2014-T652	2x8	341007	W1	3	1.501	0.7501	251	5.400	156.000	0.688	2.450	24.000	0.352
			W1	3	1.500	0.7510	251	6.200	152.000	0.728	2.200	24.300	0.410
			W1	3	1.500	0.7523	251	5.900	126.000	0.728			0.353
			W1	3	1.501	0.7512	251	5.800	242.000	0.727	1.650	19.300	0.221
			W1	4	2.000	0.9996	605	8.100	141.000	0.925	3.920	26.200	0.393
			W1	3	2.001	0.9996	605	8.600	107.000	0.970	3.670	26.500	0.409
			W1	4	2.002	0.9992	605	8.600	131.000	0.968	3.750	27.100	0.418
			W1	3	1.997	0.9990	605	9.500	68.000	1.030	2.575	20.300	0.243
			W1	5	3.003	1.5020	1.529	13.400	91.000	1.477	7.980	35.400	0.801
			W1	3	3.002	1.5020	1.529	11.600	120.000	1.472	8.550	32.800	0.690
			W1	5	3.001	1.5020	1.529	12.100	100.000	1.485	8.520	34.200	0.750
			W1	3	3.002	1.5020	1.529	13.200	63.000	1.497	5.650	23.000	0.378
			W1	1	0.500	0.2500	448	82.600	68.000	0.282	26.4	19.000	0.215
			W1	3	0.501	0.2506	448	72.400	61.000	0.268	25.2	19.000	0.200
			W1	5	3.001	1.5000	1.519	12.300	65.000	1.522	5.210	22.700	0.399
			W1	3	3.001	1.5000	1.519	14.400	79.000	1.642	4.950	23.700	0.369
			W1	5	3.001	1.5000	1.519	13.200	63.000	1.527	5.650	23.000	0.378
			W1	3	3.002	1.5000	1.519	14.400	79.000	1.642	4.950	23.700	0.369
			W1	5	3.001	1.5000	1.519	13.200	63.000	1.527	5.650	23.000	0.378
			W1	3	3.004	1.5000	1.519	127.000	205.000	1.530	7.180	28.200	0.528
			W1	5	3.002	1.5000	1.519	13.700	132.000	1.597	4.550	20.700	0.326
			W1	3	3.002	1.5000	1.519	14.600	225.000	1.662	3.650	17.900	0.243
			W1	2	1.000	0.4999	200	8.600	126.000	0.467	9.920	17.800	0.233
			W1	3	1.000	0.4995	200	8.700	152.000	0.470	1.015	19.600	0.267
			W1	6	4.001	2.0050	2.368	13.700	63.000	2.195	12.900	47.200	1.839
			W1	3	4.003	2.0050	2.0040	2.368	120.000	1.815	2.250	55.700	2.483
			W1	6	4.007	2.0040	2.368	13.800	225.000	2.215	7.200	22.800	0.389
			W1	3	4.003	2.0050	2.0030	2.368	62.000	2.092	11.350	25.400	0.665
			W1	2	1.002	0.5001	200	19.700	271.000	0.535	1.950	24.900	0.223
			W1	3	1.001	0.5000	200	18.000	189.000	0.443	1.250	22.100	0.200
			W1	1	1.001	0.5000	200	8.700	271.000	0.468	1.250	21.800	0.227

Continued

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Table VII (Cont'd)

TABLE VII (continued)
 RESULTS OF NOTCH-BEND FRACTURE TOUGHNESS TESTS
 OF STRESS-RELIEVED ALUMINUM ALLOY HAD FORGINGS
 (P23615-68-C-1385)

Sample No.	Alloy and Temp. Number	Cross- Sect. Size, in.	Direction* and Number	Specimen Type See Fig. 2 First Part	Fatigue Pre-Cracking*			Crack Length, (a), in.	Load, (P), lb	K _Q ,** per in. $2.5(\frac{P}{a})^2$, in.	At 5 Per Cent Offset Thickness, in.	Meaningful K _{Ic}	Fracture Appearance Photo	
					Max. Load(P), lb	Stress Intensity, K_F , per in.	Cycles							
2024-T652	2x8	341017	W1 2 3	3 1.501 1.501	0.7516 0.7506 0.7516	251 6 400 5 200	6 600 102 000 134 000	0.707 0.710 0.697	2 140 2 150 2 500	22 600 25 200 24 300	0.305 0.403 0.295	Yes Yes†	15	
			W1 2 3	3 1.501 1.501	0.7519 0.7537 0.7491	251 6 500 6 500	5 200 642 000 682 000	0.687 0.687 0.687	2 470 2 280 1 660	24 100 23 500 19 600	0.256 0.256 0.240	Yes† Yes†	22	
3x12	341018	W1 2 3	4 2.002 2.000	1.997 0.9990 0.9995	0.9997 0.9990 0.9995	605 8 300 8 400	8 300 174 000 171 000	0.925 0.940 0.950	2 600 2 310 3 150	24 600 22 600 21 900	0.240 0.268 0.270	Yes Yes Yes	15 20 15	
			W1 2 3	4 2.001 2.000	1.0000 0.9994 1.0010	605 605 605	7 900 9 300 9 400	175 000 80 000 17 000	0.905 1.010 1.020	2 990 2 175 2 175	19 400 16 700 16 900	0.198 0.146 0.150	Yes Yes† Yes†	0 0 0
4x16	341020	W1 2 3	5 3.002 3.001	1.5000 1.5000	1.5000 1.5000	1 307 1 307	10 200 12 200	123 000 115 000	1.482 1.645	6 240 5 840	25 000 28 900	0.365 0.459 0.488	Yes† Yes† Yes	10 20 20
			W1 2 3	5 3.002	1.5000	1 307	9 900	174 000	1.445	7 500	28 900			
			W1 2 3	1 0.500 0.501 0.500	0.2495 0.2498 0.2499	45 45 45	7 500 7 100 7 100	58 000 62 000 74 000	0.267 0.272 0.259	22 23 22 23 25 4	15 000 12 800 16 100	0.154 0.169 0.178	Yes Yes Yes	0 0 5
5x20	341023	W1 2 3	5 3.003 3.002 3.001	1.5030 1.5020 1.5040	1.5030 1.5020 1.5040	1 307 1 307 1 307	9 400 10 900	150 000 163 000 163 000	1.356 1.400 1.502	7 380 7 110 6 620	27 000 26 100 28 300	0.599 0.562 0.658	Yes Yes† Yes†	20 20 15
			W1 2 3	5 3.001 3.002 3.002	1.5000 1.5020 1.5010	1 307 1 307 1 307	9 700 10 500 11 100	146 000 173 000 176 000	1.1622 1.1507 1.1503	4 600 4 140 4 060	17 200 17 800 17 600	0.224 0.248 0.240	Yes† Yes† Yes†	0 0 0
			W1 2 3	2 1.002 1.002	0.5000 0.4999	200 200	9 900 9 200	145 000 110 000	0.5113 0.4930	685 780	15 100 16 000	0.193 0.215	No Yes† Yes†	0 0 0
			W1 2 3	6 4.002 4.001 4.003	1.9990 2.0010 2.0020	2 308 2 308 2 308	11 000 12 600 13 800	144 000 219 000 252 000	1.925 2.068 2.202	11 250 10 800 9 800	28 200 32 600 30 600	0.631 0.756 0.752	Yes Yes Yes	15 15 15
			W1 2 3	2 1.001 1.002	0.5002 0.5002 0.5003	187 187 187	9 300 9 100 9 100	276 000 270 000 234 000	0.512 0.505 0.507	740 685 800	16 400 14 800 17 300	0.230 0.168 0.257	Yes† Yes† Yes	0 0 0

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Table VII (Cont'd)

TABLE VII (Continued)
 RESULTS OF NOTCH-BEND FRACTURE TOUGHNESS
 OF STRESS-RELIEVED ALUMINUM ALLOY BAND PLATES
 (P35615-68-C-1385)

Alloy and Temper	Sample Cross- Section Size, in.	Direction* and Number	Specimen Type See Fig. 2 First Fig.	Specimen			Fatigue Pre-Crack Test			At 5 Per Cent Secant Offset			Meaningful K _c in.	Fracture Surface Percentage		
				Width(4), in.	Thickness, in. near(B), in.	Max. Load(P), lb.	Stress Intensity, K _f , psi/in.	Cycles (a), in.	Load ^b (P _c), lb.	K _c psi/in. $2.5(\frac{P_c}{t})^2$, in.	Thickness, in.					
7075-T7352	2x3	341027	1x1	3	1.458	0.7510	251	5 800	98 000	0.722	2 240	32 200	0.507	Yes		
			2	1.501	0.7536	251	6 100	64 000	0.757	2 650	32 300	0.527	Yes	25		
			3	1.501	0.7515	251	6 100	119 000	0.748	2 750	31 600	0.566	Yes	25		
			W11	3	1.501	0.7505	251	5 900	125 000	0.738	2 150	23 700	0.520	Testt	10	
			2	1.459	0.7511	251	6 700	185 000	0.765	1 920	24 000	0.538	Testt	5		
			3	1.501	0.7528	251	6 100	185 000	0.750	2 160	24 200	0.543	Testt	5		
3x12	341028	1x1	4	1.998	0.9990	504	7 100	116 000	0.955	4 330	30 500	0.520	Yes	40		
			2	2.001	0.9998	504	7 500	120 000	0.953	4 120	30 600	0.525	Yes	40		
			3	1.998	0.9985	504	7 400	243 000	0.953	4 500	33 100	0.626	Yes	18		
			W11	4	1.997	0.9980	605	10 000	62 000	1.055	3 280	27 200	0.524	Testt	0	
			2	2.003	0.9996	605	13 900	91 000	0.992	3 170	23 500	0.591	Yes	5		
			3	1.997	1.0000	605	8 700	97 000	0.968	3 175	22 800	0.369	Yes	0		
			1x1	5	3.003	1.5000	1 282	12 500	229 000	1.677	6 940	34 600	0.843	Yes	10	
			2	3.003	1.5000	1 282	11 600	197 000	1.595	6 950	31 200	0.687	Yes	5		
			3	1.4980	1.4980	1 282	11 600	205 000	1.610	7 010	32 400	0.739	Yes	5		
			W11	5	3.003	1.5000	1 282	12 900	265 000	1.702	5 490	28 200	0.651	Year	4	
			2	3.002	1.5000	1 282	13 400	321 000	1.732	4 670	24 300	0.508	Year	0		
			3	3.001	1.4990	1 282	11 500	189 000	1.558	5 770	26 300	0.569	Yes	0		
			W11	1	0.500	0.2491	45	7 900	81 000	0.273	240	16 900	0.261	Yes	0	
			2	0.501	0.2498	45	7 500	61 000	0.252	243	18 000	0.294	Yes	0		
			3	0.500	0.2495	45	7 500	93 000	0.267	275	18 500	0.311	Yes	10		
5x20	341033	1x1	5	3.003	1.5020	1 307	11 200	119 000	1.577	7 920	25 100	1.119	Testt	10		
			2	3.004	1.5030	1 307	10 500	123 000	1.507	8 080	23 200	1.002	Testt	10		
			3	1.5000	1.5000	1 307	11 700	103 000	1.607	7 950	26 500	1.211	Testt	10		
			W11	5	3.002	1.5000	1 307	10 900	102 000	1.557	6 720	28 600	0.794	Testt	0	
			2	3.002	1.5000	1 307	11 100	105 000	1.553	6 540	28 300	0.780	Testt	5		
			3	3.002	1.5010	1 307	10 500	65 000	1.505	6 600	27 100	0.715	Testt	5		
			W11	2	1.001	0.5000	200	8 300	155 000	0.493	915	19 000	0.372	Yes	0	
			3	1.001	0.5000	200	8 900	137 000	0.478	970	19 600	0.396	Yes	0		
			W11	3	1.001	0.5000	200	8 400	95 000	0.458	360	18 300	0.344	Yes	0	
			6x24	341036	1x1	6	3.998	2.0020	2 500	14 200	141 000	2.138	13 200	1.668	Year	5
			2	3.997	2.0020	2 500	14 500	87 000	2.160	12 900	39 200	1.601	Year	10		
			3	3.997	2.0020	2 500	15 100	143 000	2.203	13 100	41 400	1.814	No	20		
			W11	6	4.002	2.0020	2 500	13 900	135 000	2.118	9 500	27 800	0.859	Testt	0	
			2	4.001	2.0030	2 500	14 600	275 000	2.173	9 000	27 600	0.848	Testt	0		
			W11	2												

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Table VII (Concl'd)

TABLE VII (Concluded)
 RESULTS OF NOTCHED-BEAD FRACTURE TOUGHNESS TESTS
 OF STRESS-RELIEVED ALUMINUM ALLOY HAD PORGINGS
 (P32615-68-C-1985)

Alloy and Temper Number	Sample Gross- Size, in.	Direction ^a and Number	Specimen Type See Fig. 2	Specimen			Fatigue Pre-Cracking ^b			At 5% Dent Segment Offset ^c				
				Width (w), in.	Thickness (t), in.	Width (w), in.	Max. Load (P), lb	Stress Intensity, K _f , psi/in. E _f , psi/in.	Cycles to Failure (n), in.	Lens Length (a), in.	Lens Width (b), in.	Lens Area (A), in. ²	Meaningful K _{IC} , psi/in. ²	Fatigue Appearance at Failure ^d
7072-T652	2x8	341037	L1 ^e	2	1.199	0.7528	251	6,200	25,000	0.753	2,275	27,700	0.719	Yes Test
			L1 ^e	3	1.199	0.7501	251	6,000	24,000	0.733	2,275	27,400	0.720	Yes Test
			L1 ^e	3	1.199	0.7509	251	7,700	22,000	0.845	2,140	30,800	0.688	Yes Test
														10 25
7072	2x8	341038	L1 ^e	4	2.000	0.9999	504	7,800	15,000	1.022	3,480	27,100	0.899	Test Test
			L1 ^e	3	2.002	0.9990	504	7,700	16,000	1.015	3,440	26,400	0.855	Test Test
			L1 ^e	4	2.001	0.9980	504	7,200	17,000	0.963	2,970	21,100	0.758	Test Test
			L1 ^e	2	2.000	0.9985	504	6,500	10,000	0.950	2,770	20,500	0.734	Test Test
			L1 ^e	3	2.001	1.0000	504	6,000	10,200	1.032	3,290	26,000	0.792	Test Test
			L1 ^e	5	2.001	1.5000	1,307	11,200	53,000	1,573	5,300	36,200	0.710	Test Test
			L1 ^e	2	2.001	1.5000	1,307	11,200	53,000	1,570	5,350	36,400	0.716	Test Test
			L1 ^e	3	2.003	1.5002	1,307	11,500	52,000	1,567	5,050	27,100	0.756	Test Test
			L1 ^e	5	2.001	1.5020	1,089	10,500	14 ³ ,000	1,668	3,650	18,000	0.704	Test Test
			L1 ^e	2	2.001	1.5010	1,089	9,900	132,000	1,618	3,220	19,700	0.744	Test Test
			L1 ^e	3	2.001	1.5000	1,089	9,600	13,000	1,602	4,260	19,500	0.739	Test Test
			L1 ^e	1	0.501	0.2495	45	8,100	46,000	0.282	265	19,700	0.735	Yes Test
			L1 ^e	2	0.500	0.2497	45	7,400	89,000	0.263	265	17,800	0.655	Yes Test
			L1 ^e	3	0.500	0.2499	45	7,000	62,000	0.257	273	17,200	0.658	Yes Test
			L1 ^e	5	2.002	1.5010	1,089	10,700	11 ⁴ ,000	1,685	6,120	20,800	0.752	Test Test
			L1 ^e	2	2.002	1.5000	1,089	9,700	19,600	1,595	5,930	27,100	0.756	Test Test
			L1 ^e	3	2.002	1.5020	1,089	6,700	205,000	1,495	6,180	25,100	0.736	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5001	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test
			L1 ^e	1	1.001	0.5000	200	9,200	98,000	0.487	900	19,300	0.219	Yes Test
			L1 ^e	3	1.003	0.5000	200	10,200	97,000	0.517	6,150	25,100	0.215	Test Test
			L1 ^e	5	2.002	1.5000	1,089	9,500	67,000	1,578	5,060	22,500	0.777	Test Test
			L1 ^e	2	2.002	1.5000	1,089	10,700	113,000	1,527	5,050	25,600	0.758	Test Test
			L1 ^e	3	2.003	1.5010	1,089	10,700	81,000	1,685	4,310	21,700	0.711	Test Test
			L1 ^e	2	1.000	0.5001	200	9,100	119,000	0.485	900	19,300	0.218	Yes Test

Table VIII

TABLE VIII

RESULTS OF LONG-TRANSVERSE AXIAL-STRESS FATIGUE TESTS
OF STRESS-RELIEVED ALUMINUM ALLOY HAND FORGINGS (R=0.0)
(F33615-68-C-1385)

Alloy and Temper	Sample Size, In.	Number	Cycles to Failure			
			Maximum Stress, psi	60 000	40 000	35 000
2014-T652	2x8	341007	34 200	4 358 100	10 264 500*	
	4x8	341009	17 700	1 032 800	6 252 200	
	5x10	341012	18 900	230 000	10 017 300*	
	6x12	341015	7 700	142 200	14 323 200*	
	Log-Mean Fatigue Life		17 200	619 400	---	
2024-T852	2x8	341017	22 600	252 900	10 029 500*	
	4x8	341019	12 700	180 700	19 845 700*	
	5x10	341022	14 300	90 200	17 189 300*	
	6x12	341015	7 200	93 600	14 882 400*	
	Log-Mean Fatigue Life		13 700	140 200	---	
7075-T7352	Maximum Stress, psi		60 000	45 000	38 000	
	2x8	341027	28 100	4 084 800	14 882 600*	
	4x8	341029	4 700	82 400	1 455 800	
	5x10	341032	9 800	51 100	105 800	
	6x12	341035	3 600	38 600	93 000	
7079-T652	Log-Mean Fatigue Life		8 300	160 500	---	
	2x8	341037	22 200	109 800	720 500	
	4x8	341039	22 700	61 400	11 607 400*	
	5x10	341042	19 200	75 500	162 700	
	6x12	341045	11 400	40 200	146 400	
Log-Mean Fatigue Life			18 100	66 900	---	

* Specimen did not fail.

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TABLE IX
STATUS OF LONGITUDINAL AND LONG-TRANSVERSE STRESS-CORROSION TESTS
TRIPOLATE 0.437" DIAMETER TENSION SPECIMENS EXPOSED IN DIRECT TENSION *

Alloy and Temper	Forging Size, In.	Sample Number	Longitudinal Specimens			Long-Transverse Specimens		
			Stressed 75% Y.S. 7/14 Days		Stressed 75% Y.S. 7/14 Days	Stressed 50% Y.S. 7/14 Days		
			OK - 164	OK - 48		OK - 12	OK - 164	OK - 48
2014-T652	2 x 8	341007	0/3	OK - 164	3/3	8, 59, 64	0/3	OK - 164
	4 x 16	341010	0/3	OK - 48	0/3	OK - 48	0/3	OK - 48
	6 x 24	341016	0/3	OK - 12	0/3	OK - 12	0/3	OK - 12
	2 x 8	341017	0/3	OK - 164	0/3	OK - 164	---	---
	4 x 16	341020	0/3	OK - 48	0/3	OK - 48	---	---
	6 x 24	341026	0/3	OK - 12	0/3	OK - 12	---	---
7075-T752	2 x 8	341027	0/3	OK - 164	0/3	OK - 164	---	---
	4 x 16	341030	0/3	OK - 48	0/3	OK - 48	---	---
	6 x 24	341036	0/3	OK - 12	0/3	OK - 12	---	---
	2 x 8	341037	0/3	OK - 164	3/3	27, 59, 64	0/3	OK - 164
7379-T652	4 x 16	341040	0/3	OK - 48	2/3	20, 26(1-OK-48)	0/3	OK - 48
	6 x 24	341046	0/3	OK - 12	0/3	OK - 12	0/3	OK - 12

* Duplicate unstressed specimens were also exposed in each instance.

+ ?/N denotes number of specimens failed over number exposed.

Table IX

TABLE X
STATUS OF SHORT-TRANSVERSE STRESS-CORROSION TESTS
DUPLICATES .25" DIAMETER TENSION SPECIMENS STRESSED IN DIRECT TENSION*

Alloy and Forging Member	Forging Size, In.	Sample Number	Str. 1/2 Y.S.		Str. 2 Y.S.		Exposure: 5% NaCl Solution in Alternating Immersion		Str. 1/2 Y.S.	
			P/N	Days	P/N	Days	P/N	Days	P/N	Days
2014-T0-52	2 x 8	341007	--	--	--	--	--	OK - .4	OK - 24	OK - 34
	3 x 12	341008	--	--	--	--	--	OK - .8	OK - 24	OK - 34
	4 x 16	341010	--	--	--	--	--	OK - .4	K - 48	K - 48
	5 x 20	341012	--	--	--	--	--	OK - 34	OK - 34	OK - 34
	6 x 24	341016	--	--	--	--	--	OK - 5	OK - 5	OK - 5
2024-T0-52	2 x 8	341017	5/5	14,34,34#	5/5	OK - .4	--	--	--	--
	3 x 12	341018	0/3	OK - .4	0/5	OK - .4	--	--	--	--
	4 x 16	341020	3/3	3,2,4	2/3	OK(2-OK-4?)	--	--	--	--
	5 x 20	341023	5/5	OK - 34	5/5	OK - .4	--	--	--	--
	6 x 24	341026	0/3	OK - 5	0/5	OK - 5	--	--	--	--
7075-T6-52	2 x 8	341027	0/3	OK - 34	--	--	--	--	--	--
	3 x 12	341028\$	3/3	8,8,8	--	--	--	--	--	--
	4 x 16	341030	0/3	OK - 44#	--	--	--	--	--	--
	5 x 20	341033	0/3	OK - 34	--	--	--	--	--	--
	6 x 24	341036	0/3	OK - 5	--	--	--	--	--	--
	7075-T6-52	2 x 8	341037	--	--	--	--	OK - 34	OK - 34	OK - 34
	3 x 12	341038	--	--	--	--	--	OK - 34	OK - 34	OK - 34
	4 x 16	341040	--	--	--	--	--	3/3	3,4,4	3/3
	5 x 20	341043	--	--	--	--	--	2/3	15,27(1-OK34)	OK - 34
	6 x 24	341046	--	--	--	--	--	2/3	5,5(1-OK-5)	OK - 5

* Duplicate unstressed specimens were also exposed in each instance.

+ P/N denotes number of specimens failed over number exposed.

Specimens failed outside the reduced section, beneath the protective coating used to isolate all parts of the stressing frame.

\$ Forging to be re-tested to confirm anomalous results.

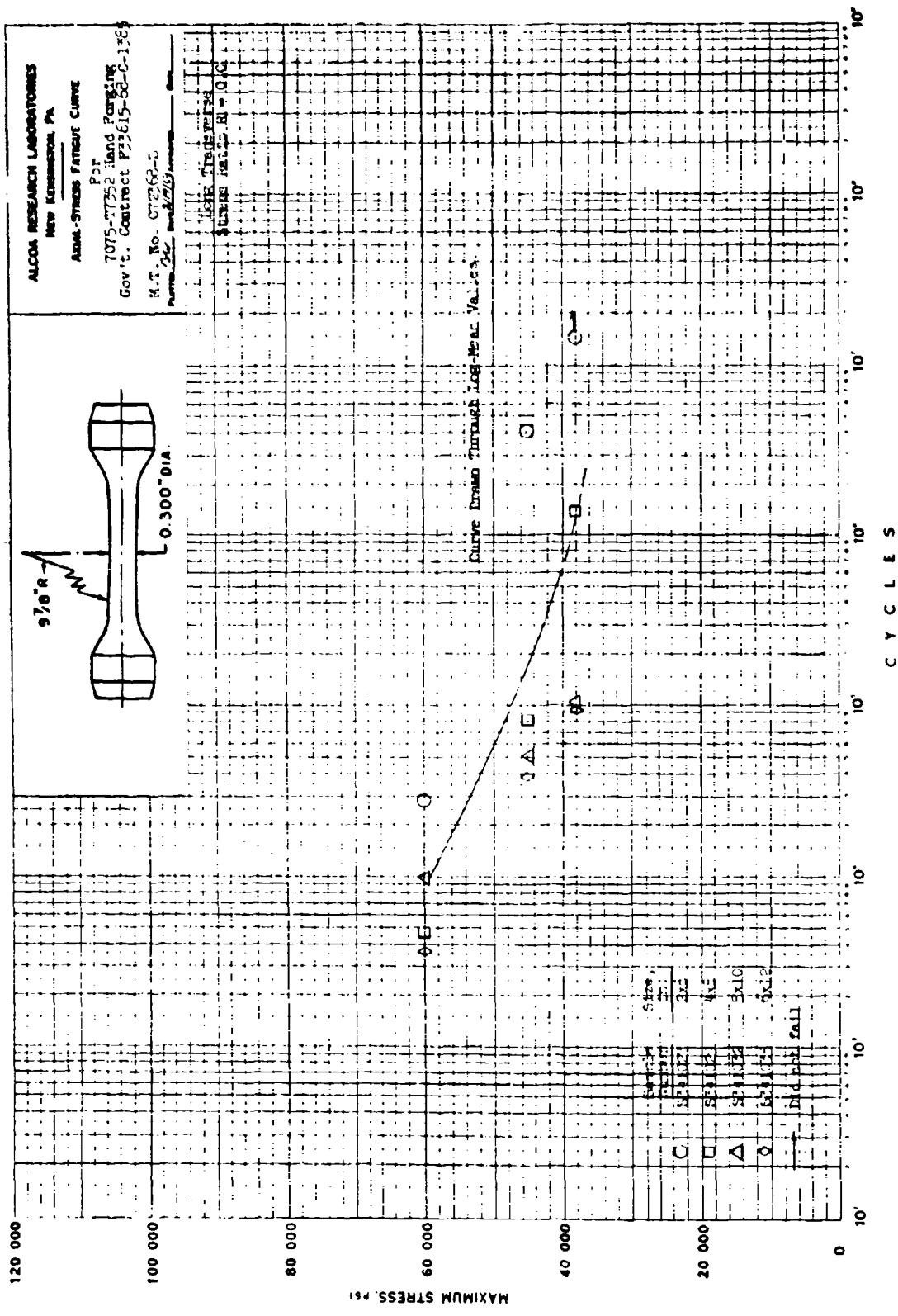


Fig. 1

Long Transverse-Biaxial - Constant Load Tests
S-34166, 6-1-24-38
Contract F33651-68-C-1385

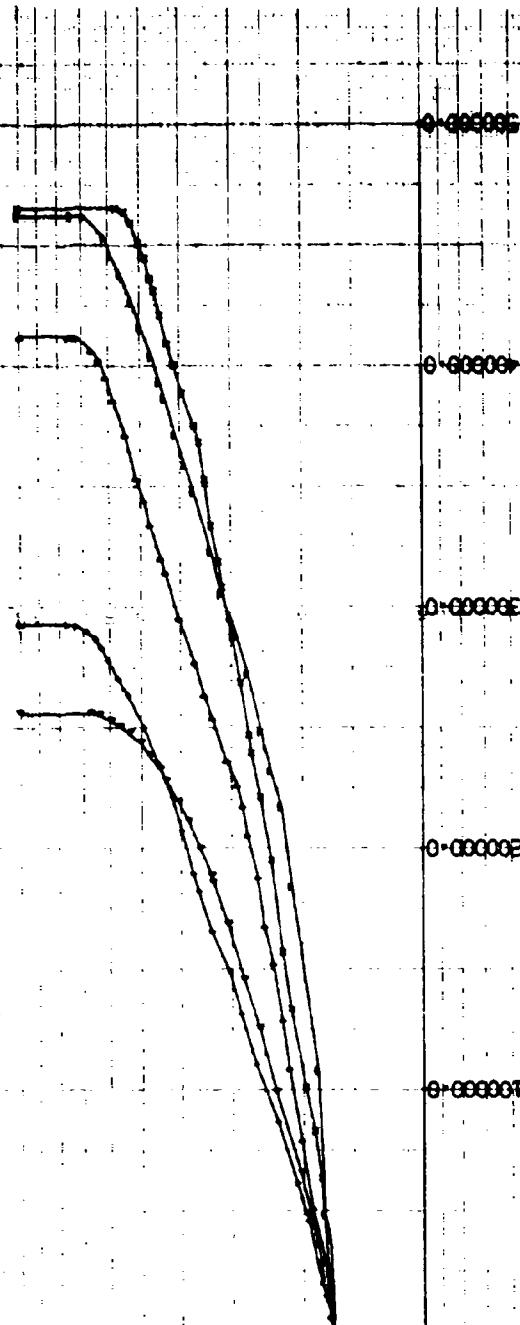
Legend:

Spec.	Max. Gross Stress, kip	Range of Biaxiality, %	Model No. 3033
+ 1	8.2	8-38	
x 4	8.2	3-28	
			"Searle" Notch
▽ 2	8.2	4-38	
▽ 5	8.2	4-25	
4 18	8.2	22-54	

R = 1/3

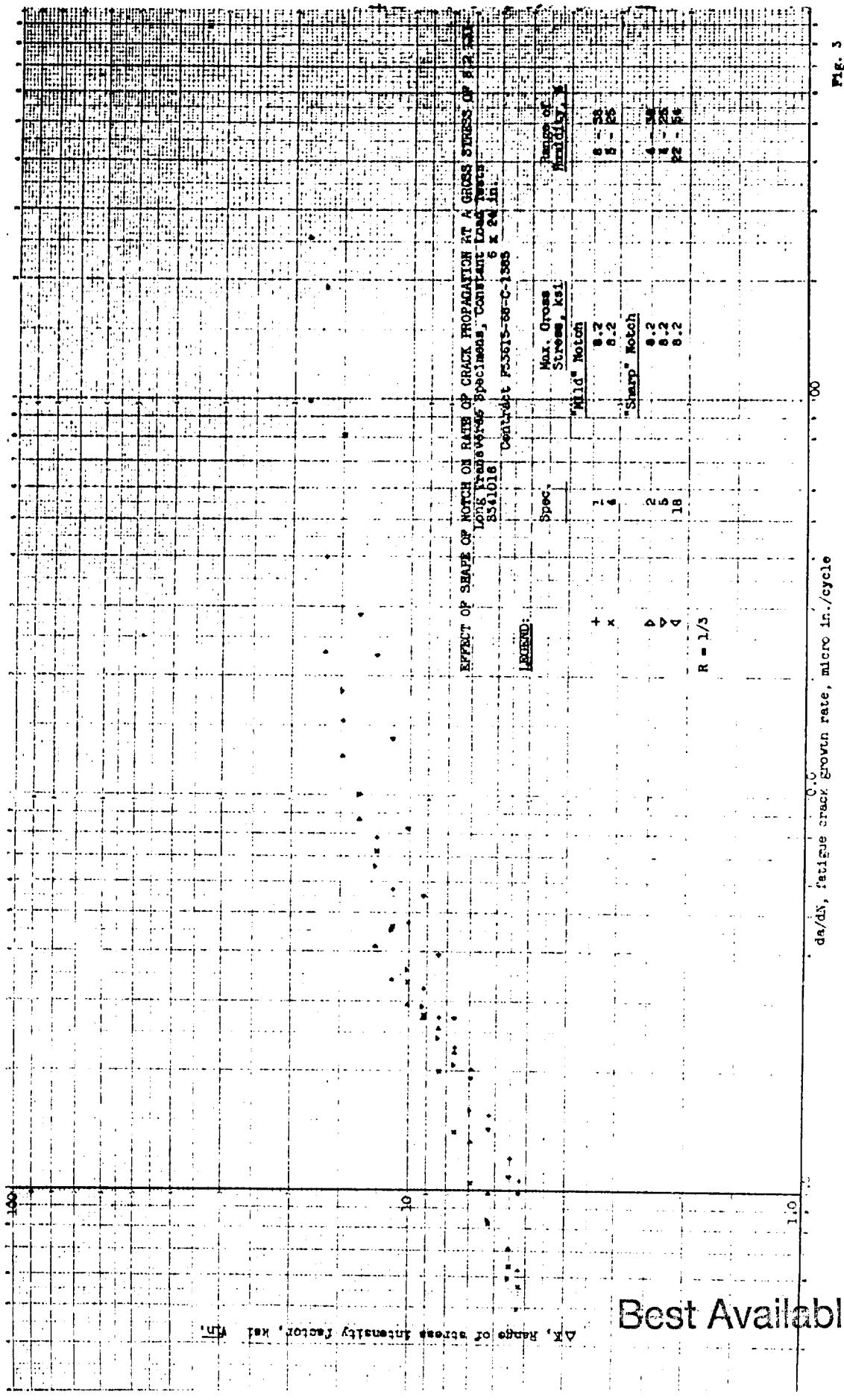
PERCENT OF AREA CRACKED

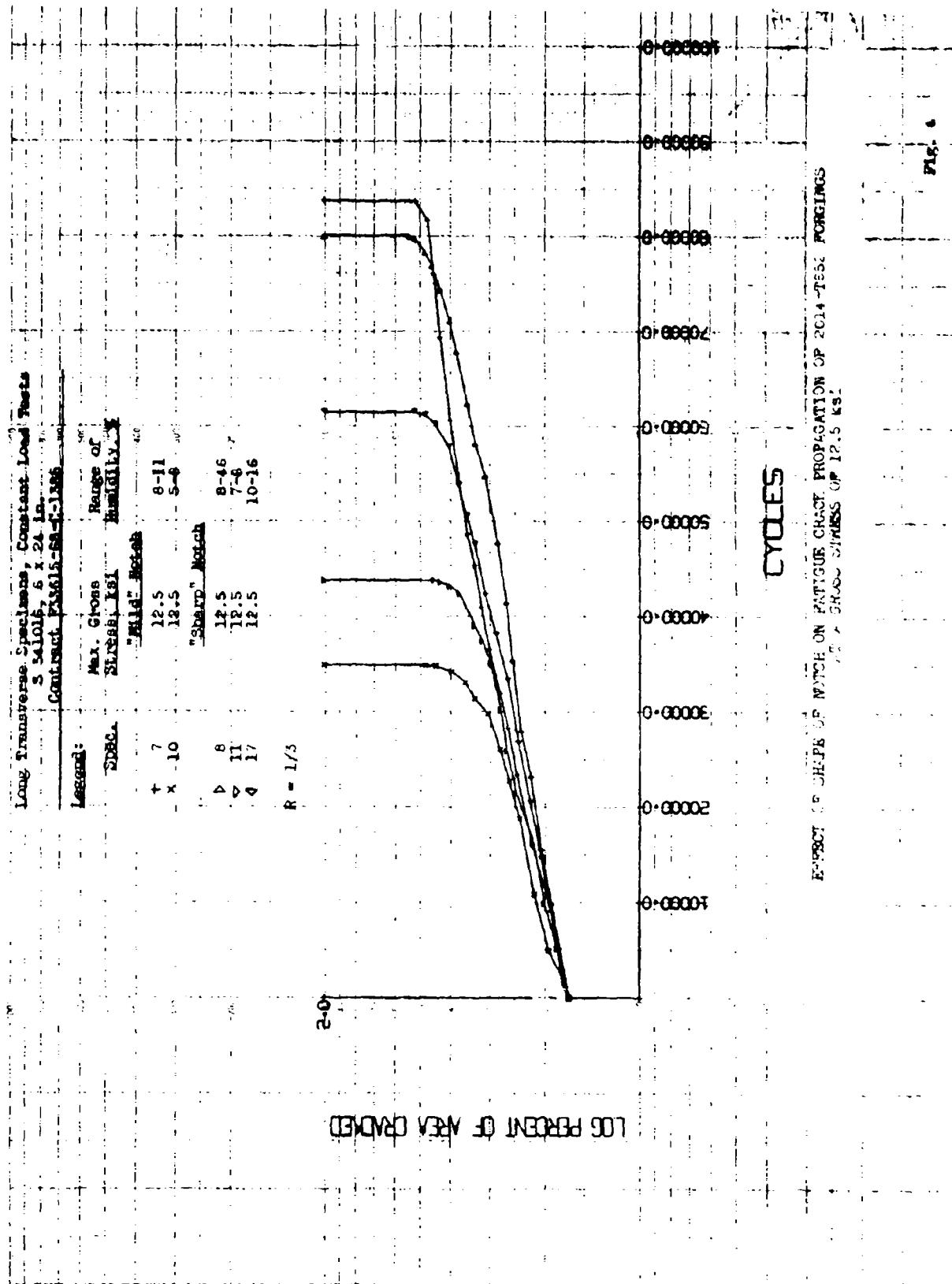
200
100
0



EFFECT OF SHAPE OF NOTCH ON FATIGUE CRACK PROPAGATION RATE
OF 2014-T652 FORGINGS AT A GROSS STRESS OF 0.2 kip

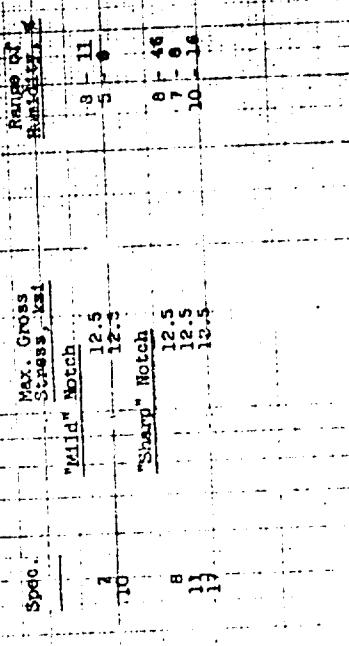
FIG. 2





EFFECT OF NOTCH ON RATE OF CRACK PROPAGATION OF 2014-1552 T-RCG-3

At a Gross Stress of 12.5 KSI
Longitudinal Specimens, Constant Load Test
331019 Contract F33657-69-C-1365



R = 1/3

cr/dN, fatigue crack growth rate, micro in./cycle

PLATE

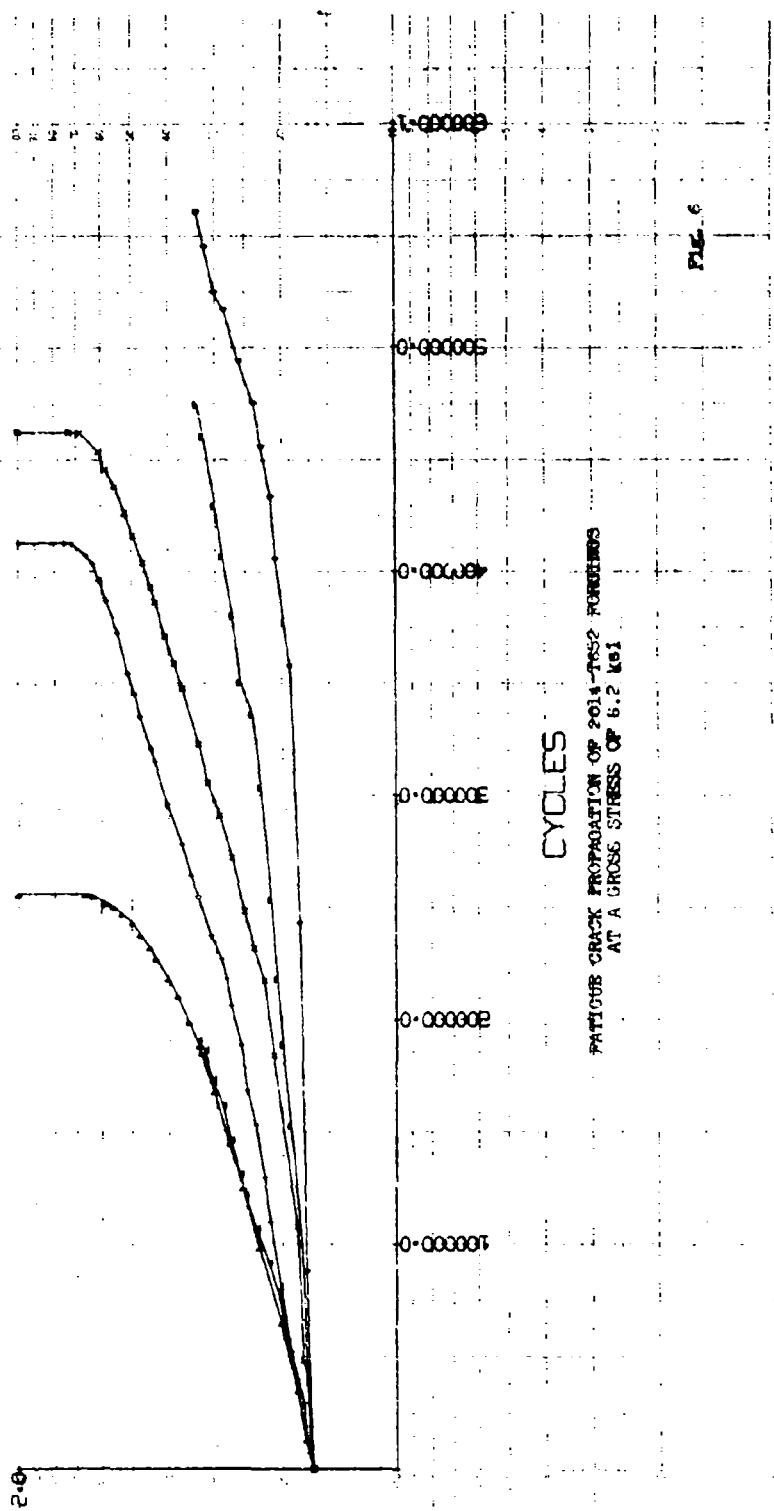
Best Available Copy

Long Transverse Specimens, Constant Load Tests
 Job No. 341016, C x 24 in.
 Contract PA3815-68-C-1385

Period:	Max. Gross Stress	Range of Humidity
+	2	6.2
x	5	6.2
o	18	8.2
▽	14	6.2
·	15	8.2
△	20	6.2
		21-50

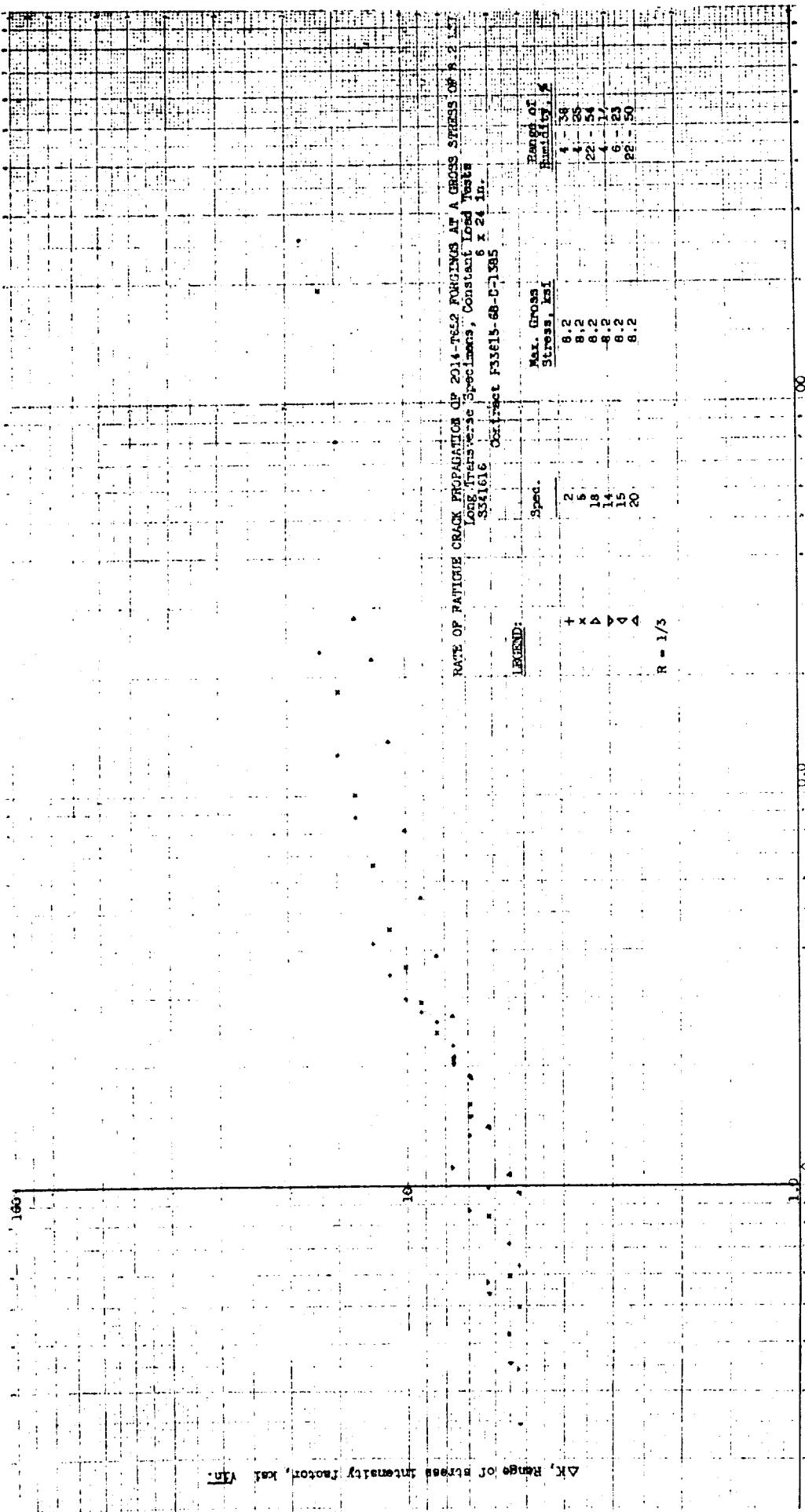
R = 1/3

PERCENT OF AREA CRACKED



PATIOT CRACK PROPAGATION ON 2014-T652 FORGINGS
 AT A GROSS STRESS OF 6.2 ksi

FIG. 6



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Long Transverse Specimens, Constant Load Tests
 Job No. 341016-6-X-24-1B
 Contract F33615-68-C-1185

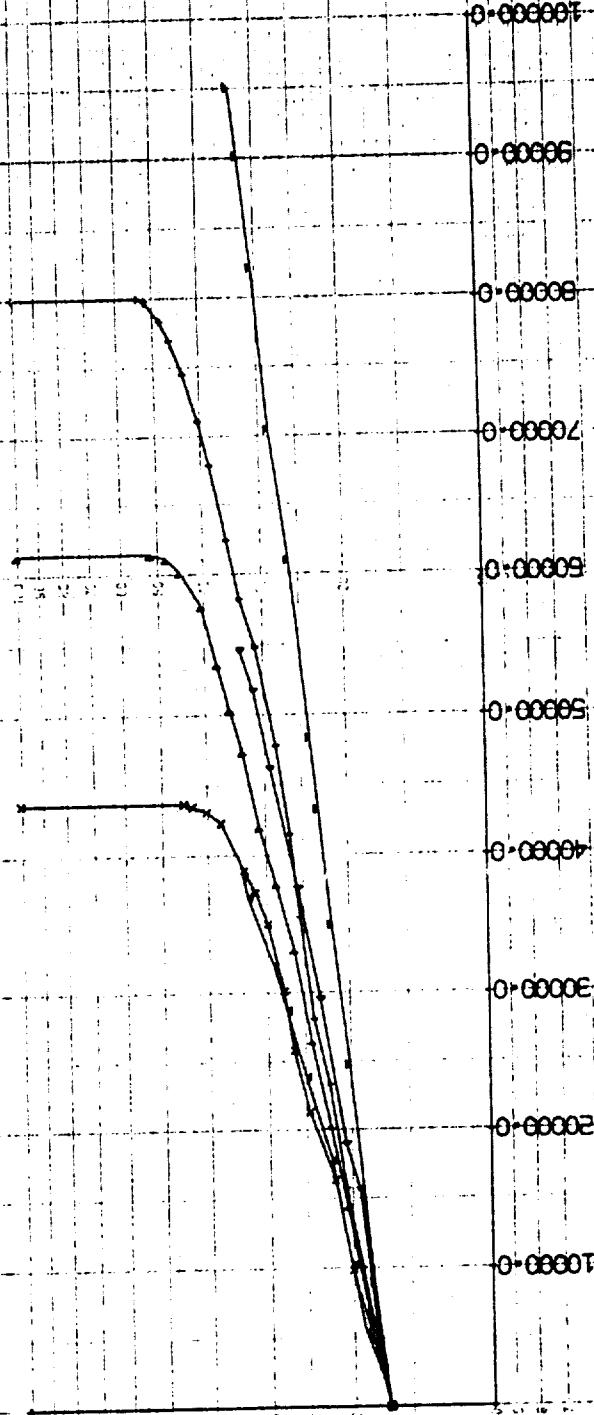
Legend:

Spec.	Max. Gross Stress, ksi	Range of Humidity, %
9	12.5	8-46
11	12.5	7-8
17	12.5	10-16
13	12.5	5-15
4	12.5	10-20
16	12.5	12-30
19	12.5	

 $R = 1/3$

LOG PERCENT OF AREA DRAINED

2.0



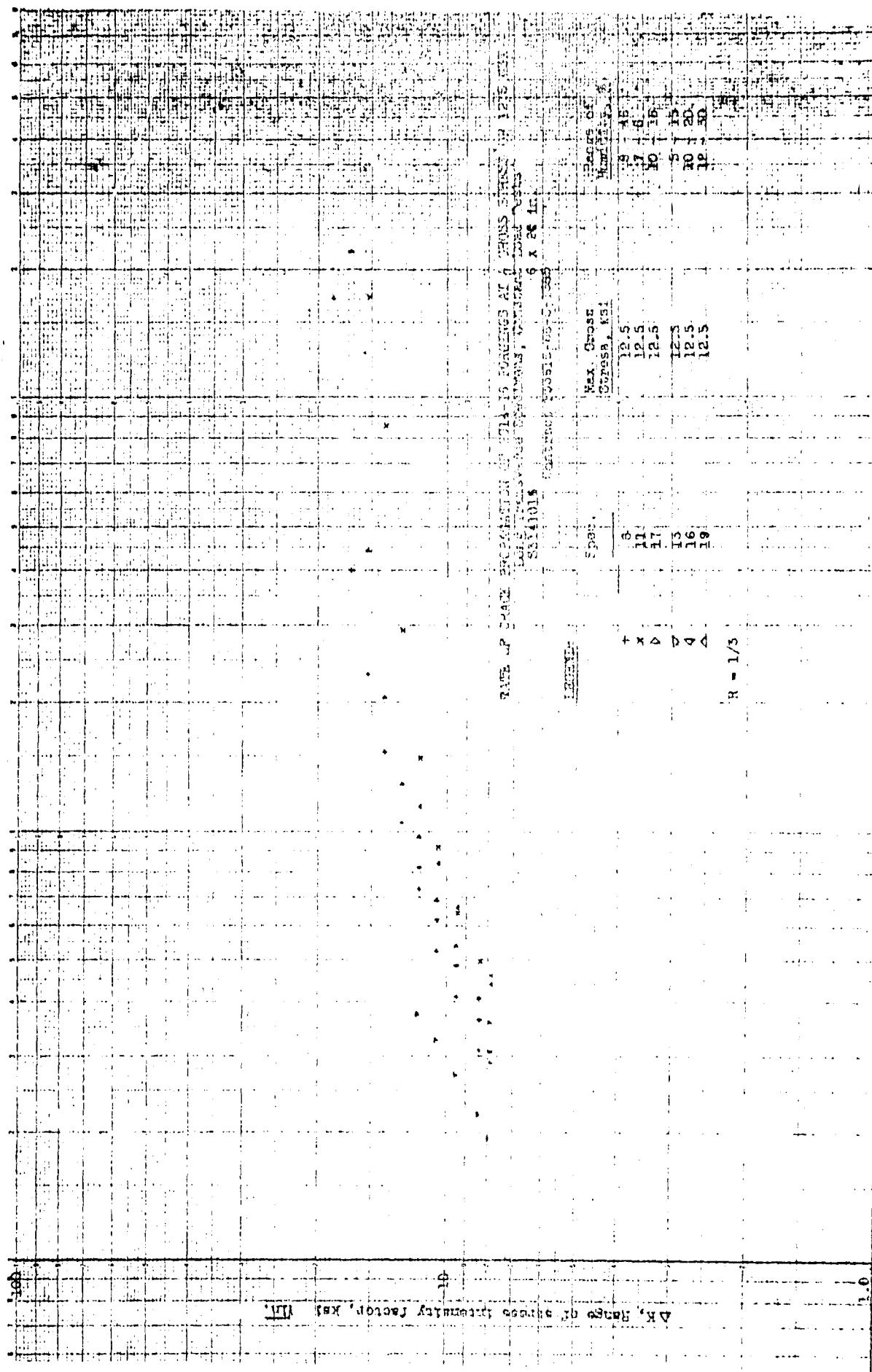
CYCLES

FATIGUE CRACK PROPAGATION OF 2014-T652 FORGINGS AT A GROSS STRESS OF 12.5 ksi

6
E

de/dt, relative track growth rate, micro m./cycle

OBÜR AVANTURIST GÖRT

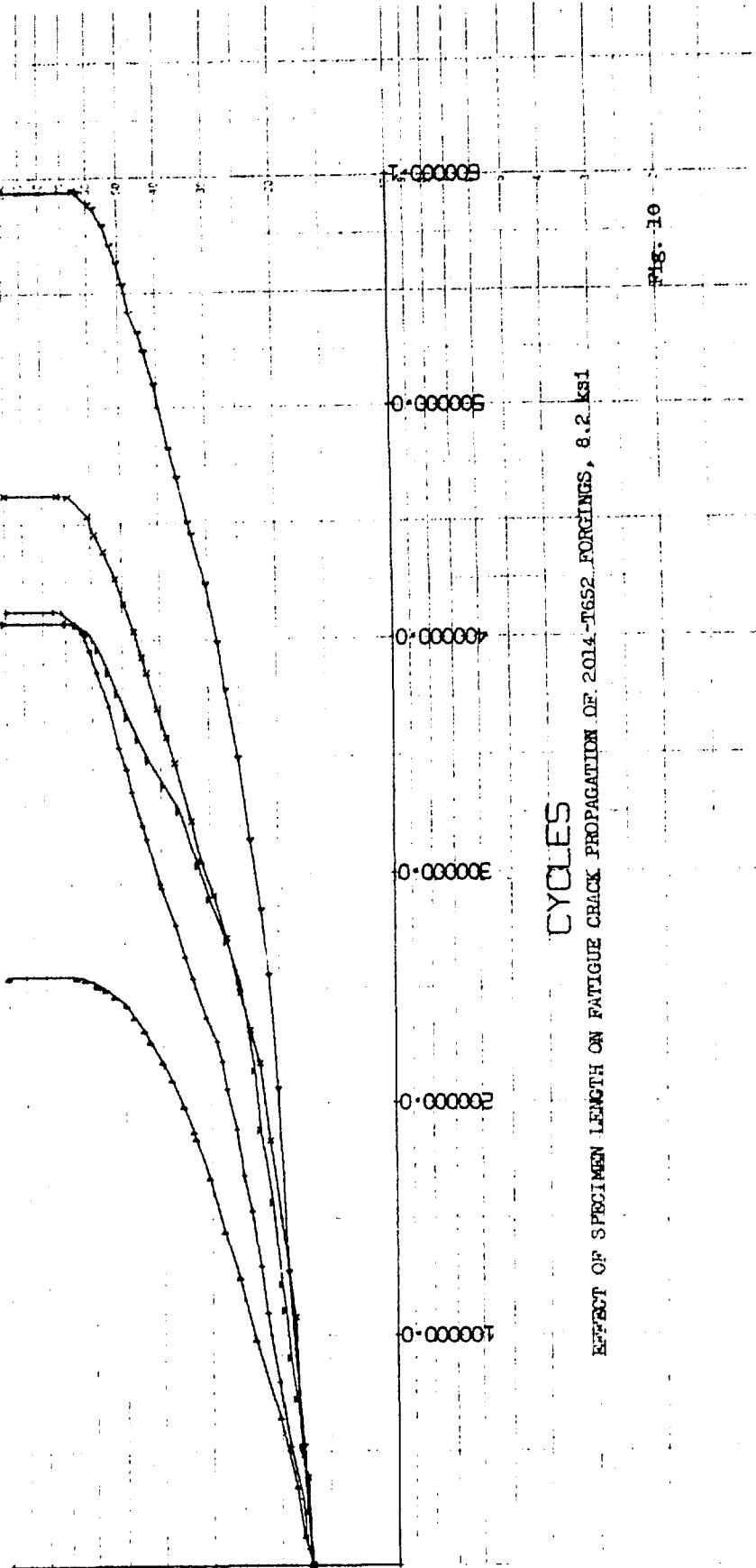


Long Transverse Specimens, Constant Load Tests
S 341016, 6 x 24 In.
Contract P-3615-68-C-1385

Legend:

Spec.	Max. Gross Stress, ksi	Range of Humidity, %
24-in. Long Specimens		
+	2	6.2
x	5	8.2
▽	16	9.2
6-in. Long Specimens		
▽	3	8.3
▽	6	8.3
R = 1/3		

PERCENT OF AREA CRACKED



EFFECT OF SPECIMEN LENGTH ON FATIGUE CRACK PROPAGATION OF 2014-T652 FORGINGS, 0.2 ksi

FIG. 10

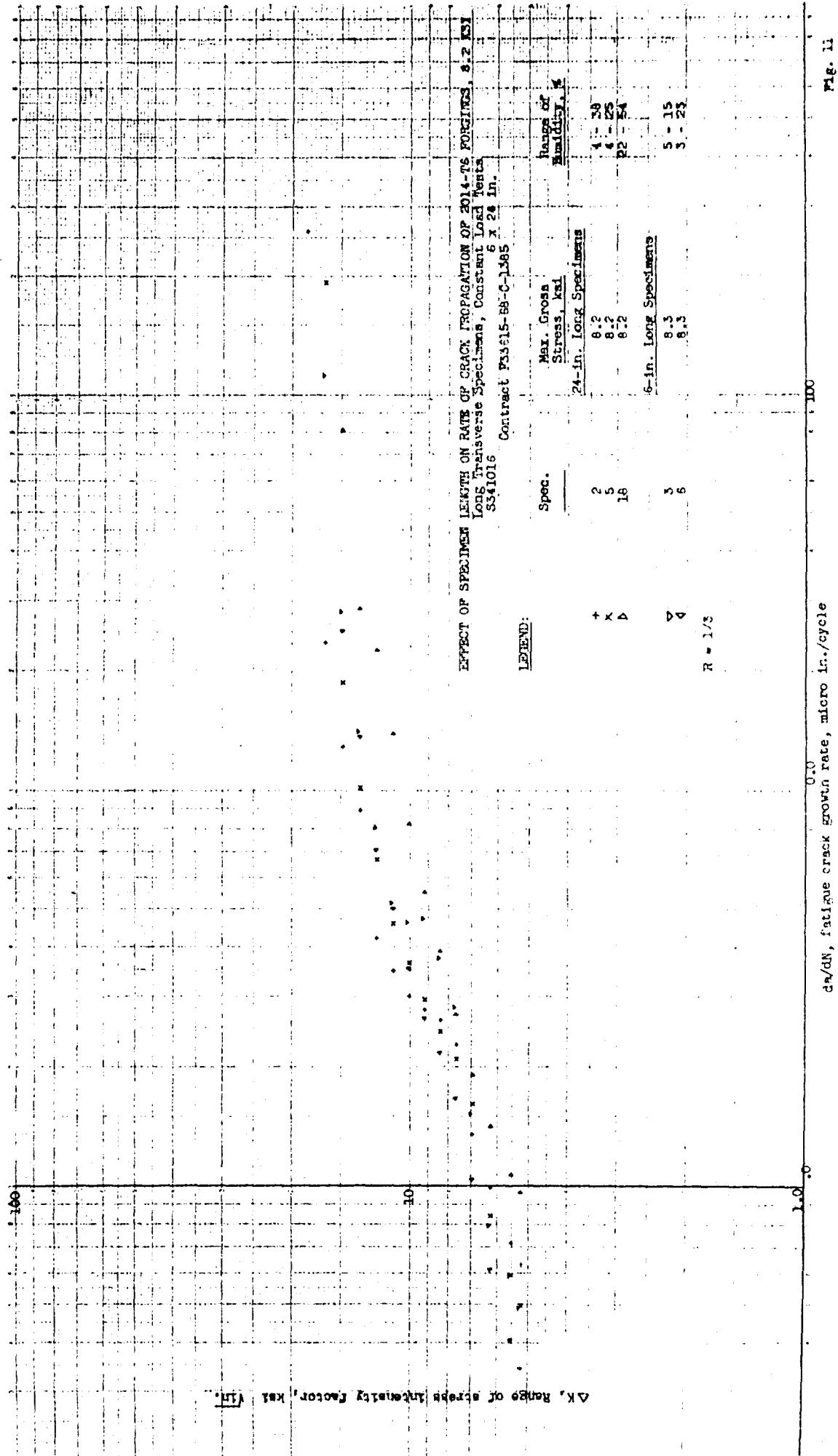
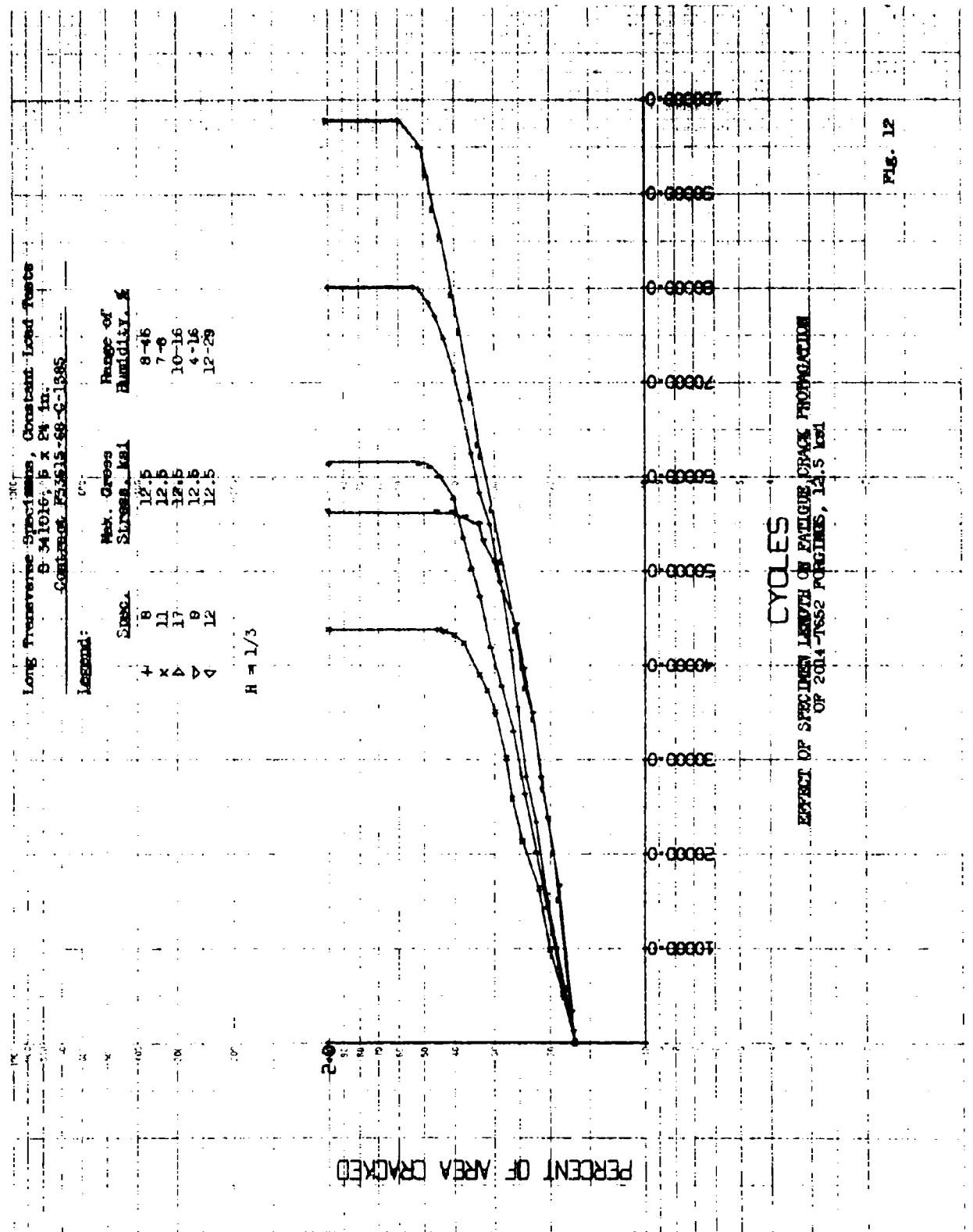
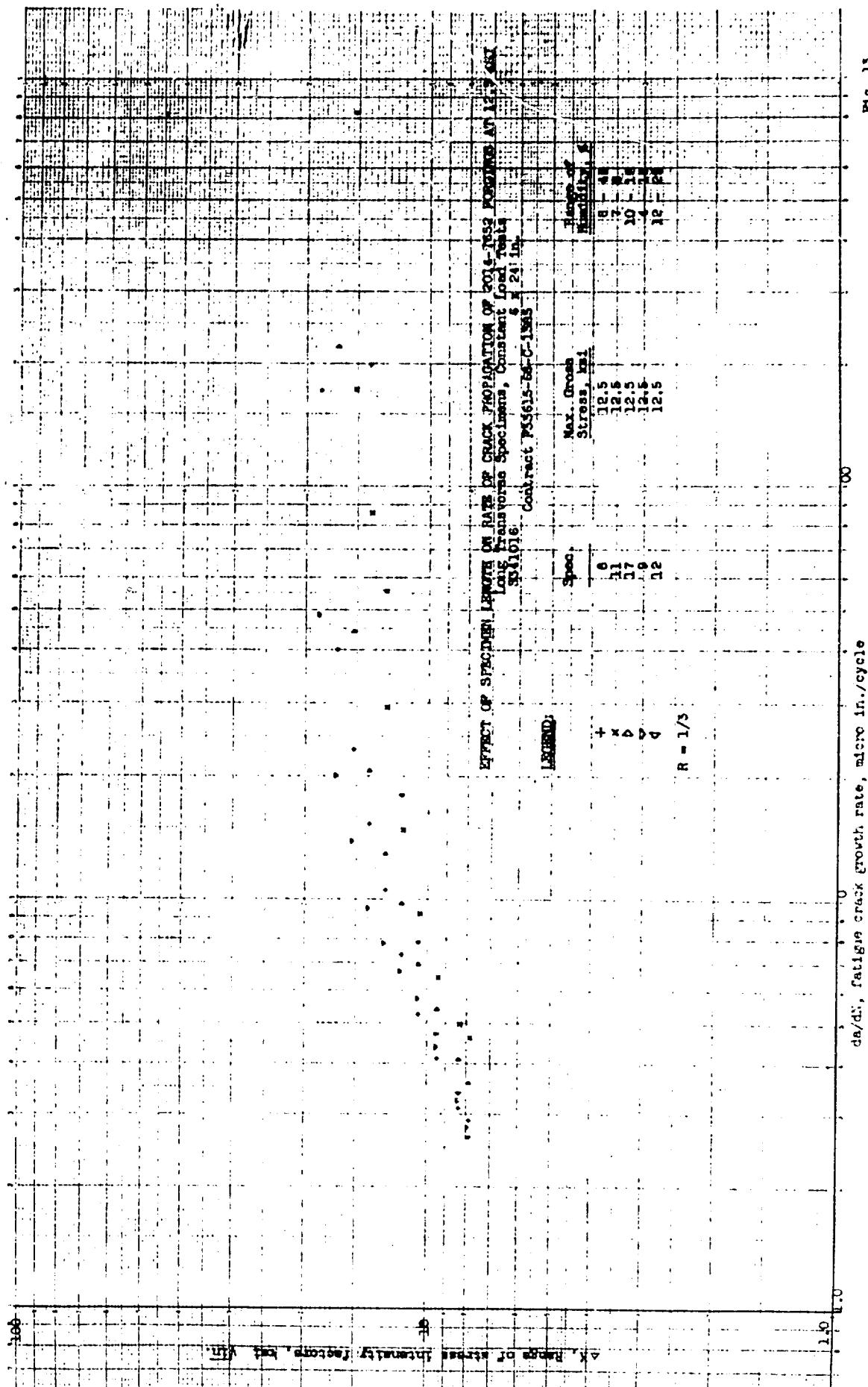


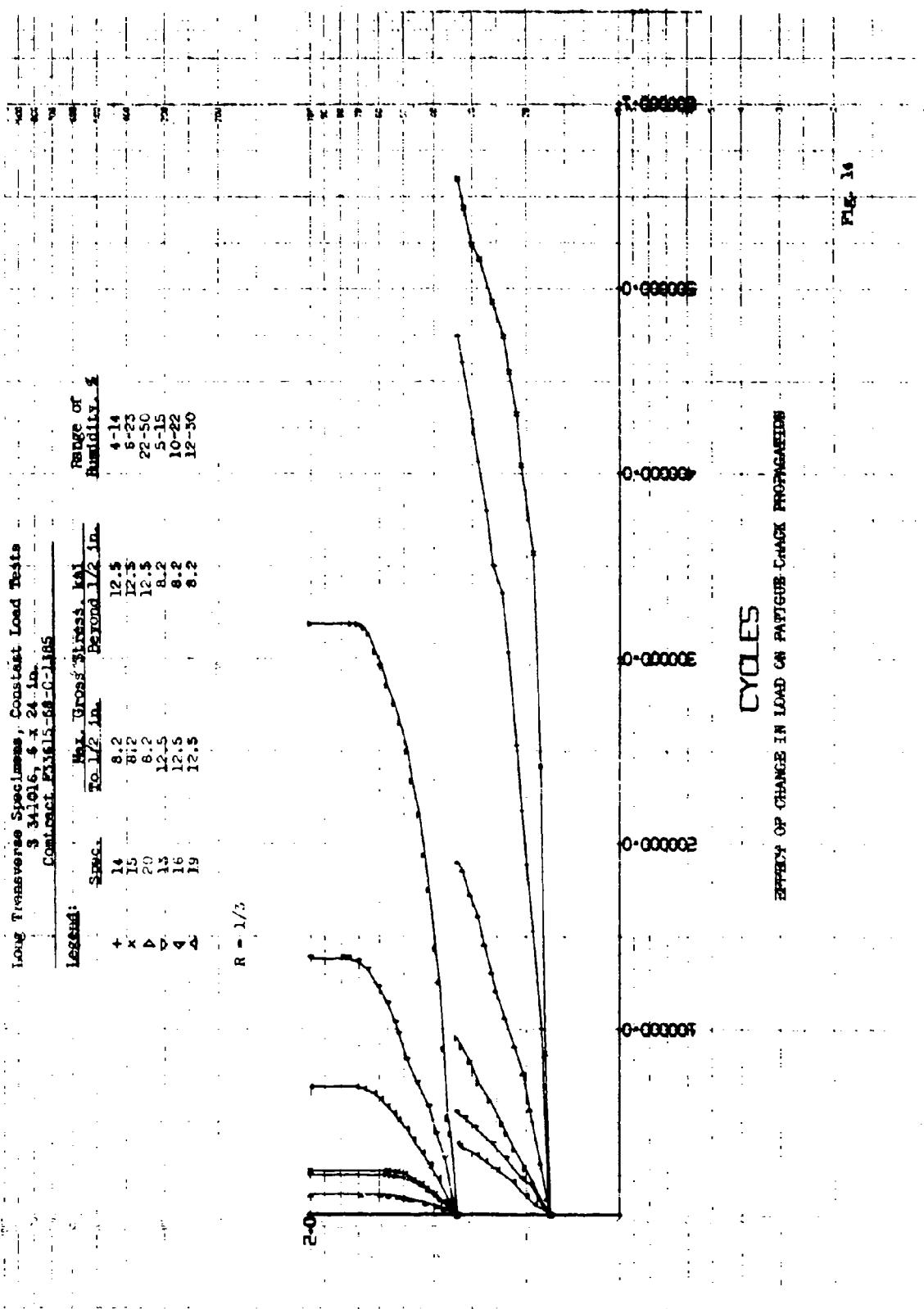
Fig. 11

 $d\sigma/dN$, fatigue crack growth rate, micro in./cycle





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EFFECT OF CHANGE IN LOAD ON FATIGUE CRACK PROPAGATION

FIG. 14

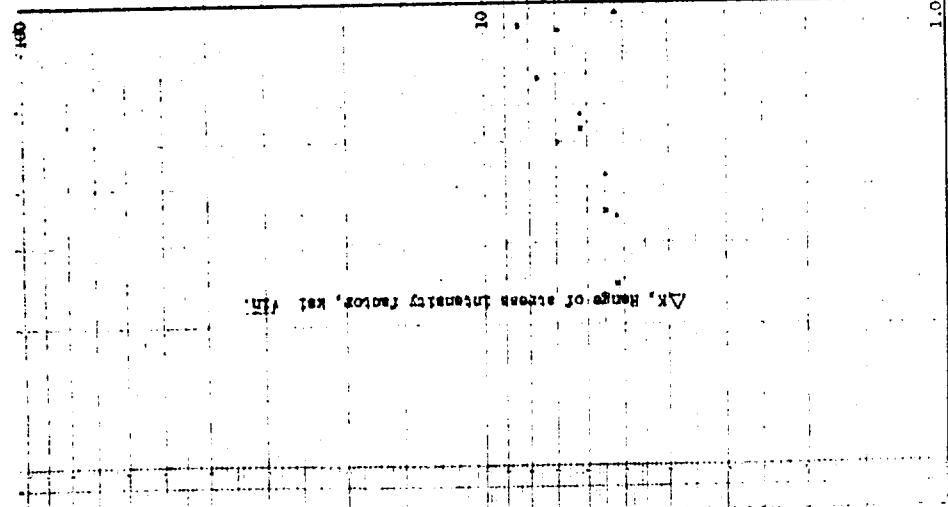


Fig. 15

ΔK, Range of crack intensity factor, kip/in.

Load Transverse Specimens, Constant Load Rate
334-2016 Certified Test Specimen No. C-138

1.0

0.8

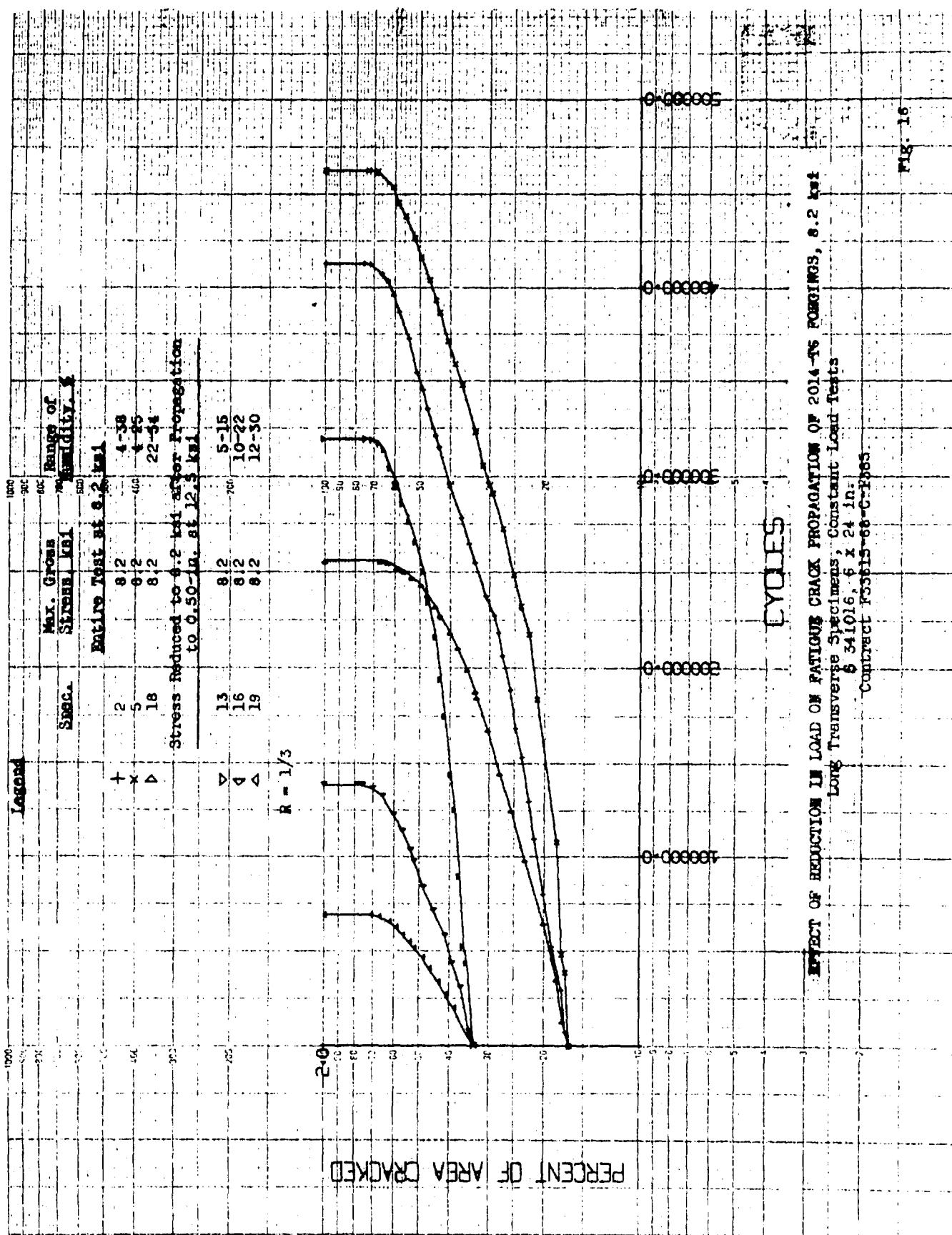
0.6

0.4

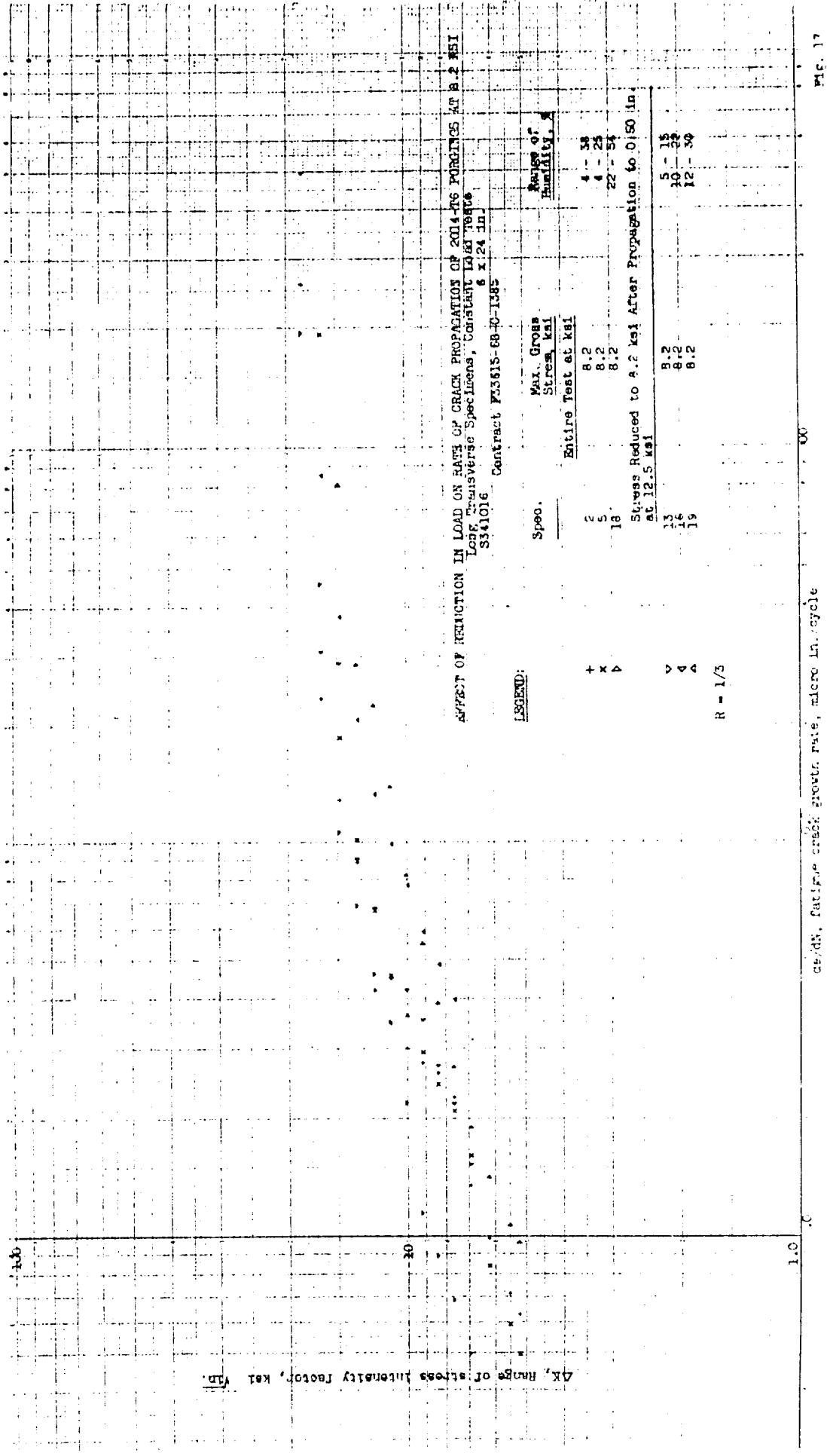
0.2

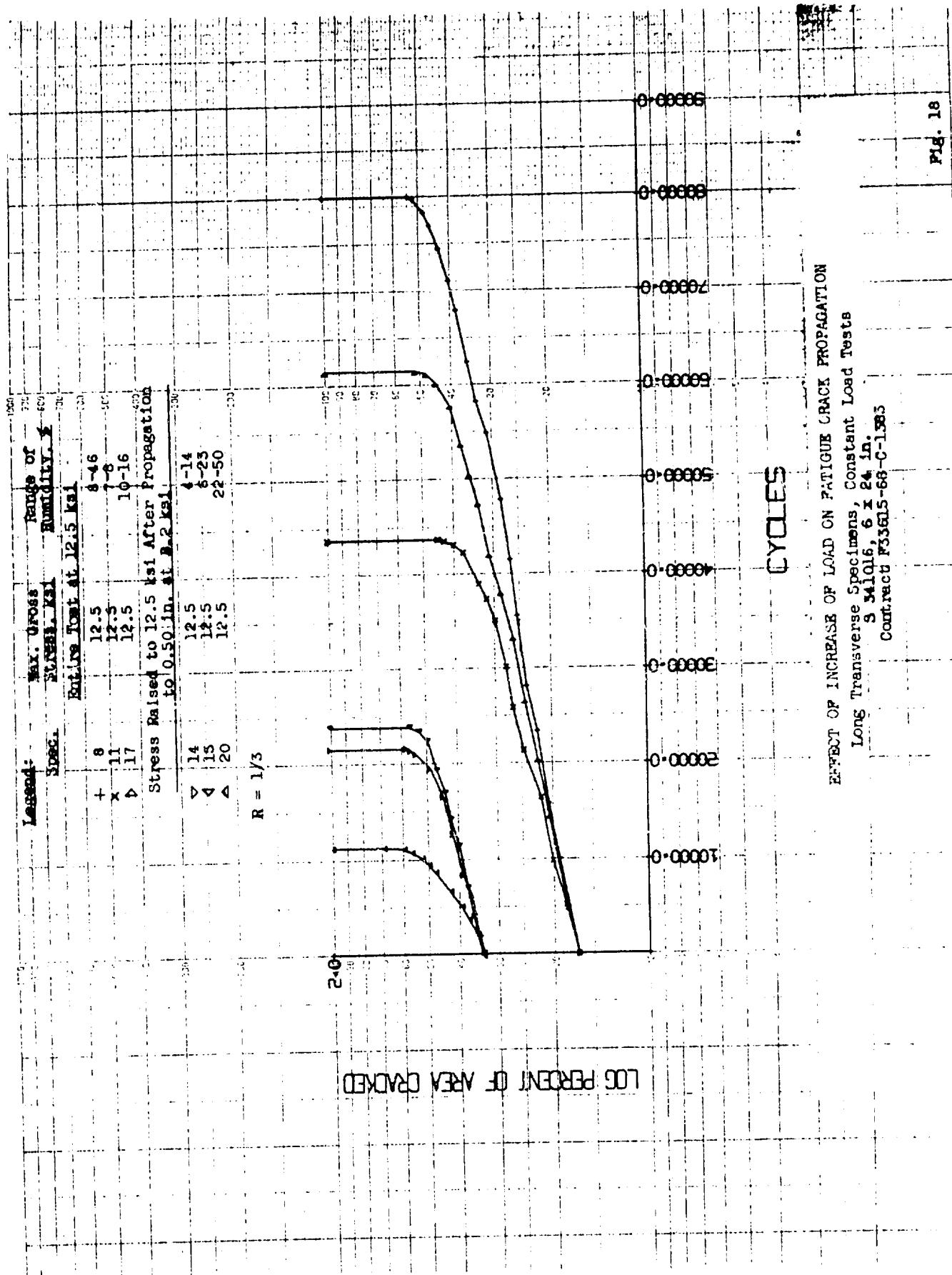
0.0

-0.2



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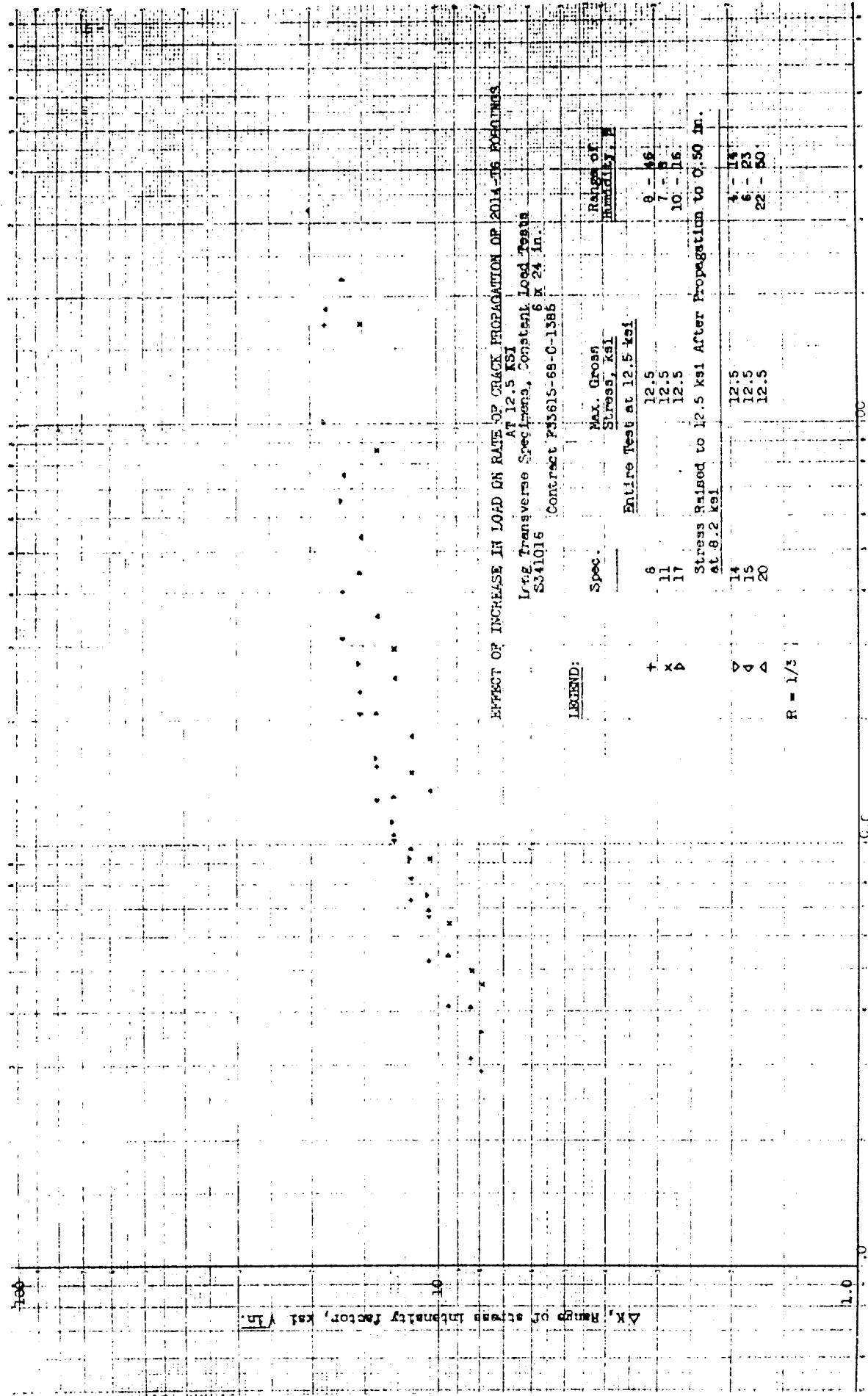


FIG. 19

C.C.
d₅₀dN, fatigue crack growth rate, micro in./cycle

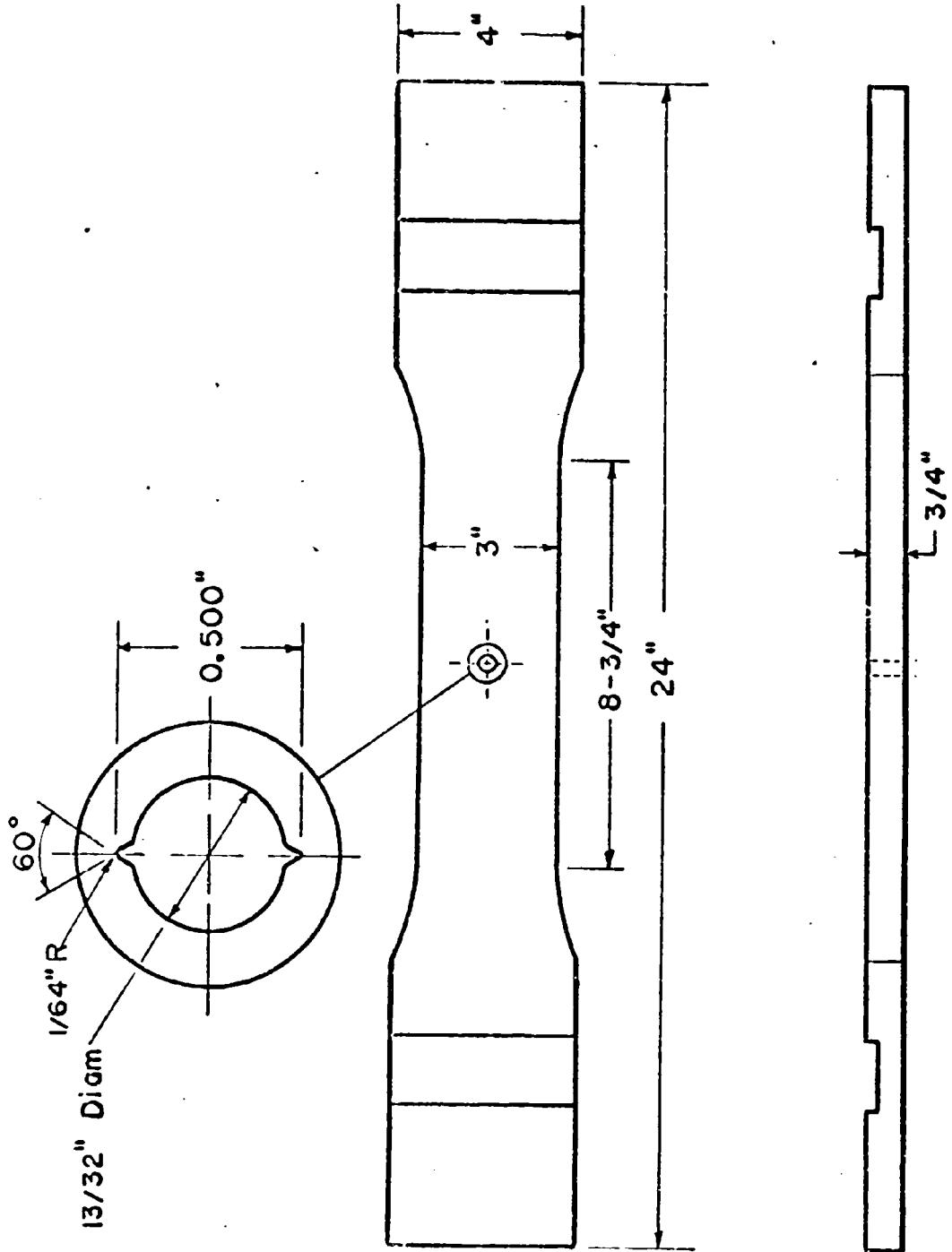


Fig. 20

FIG. 20 CENTER-NOTCHED FATIGUE SPECIMENS
(MILD NOTCH)

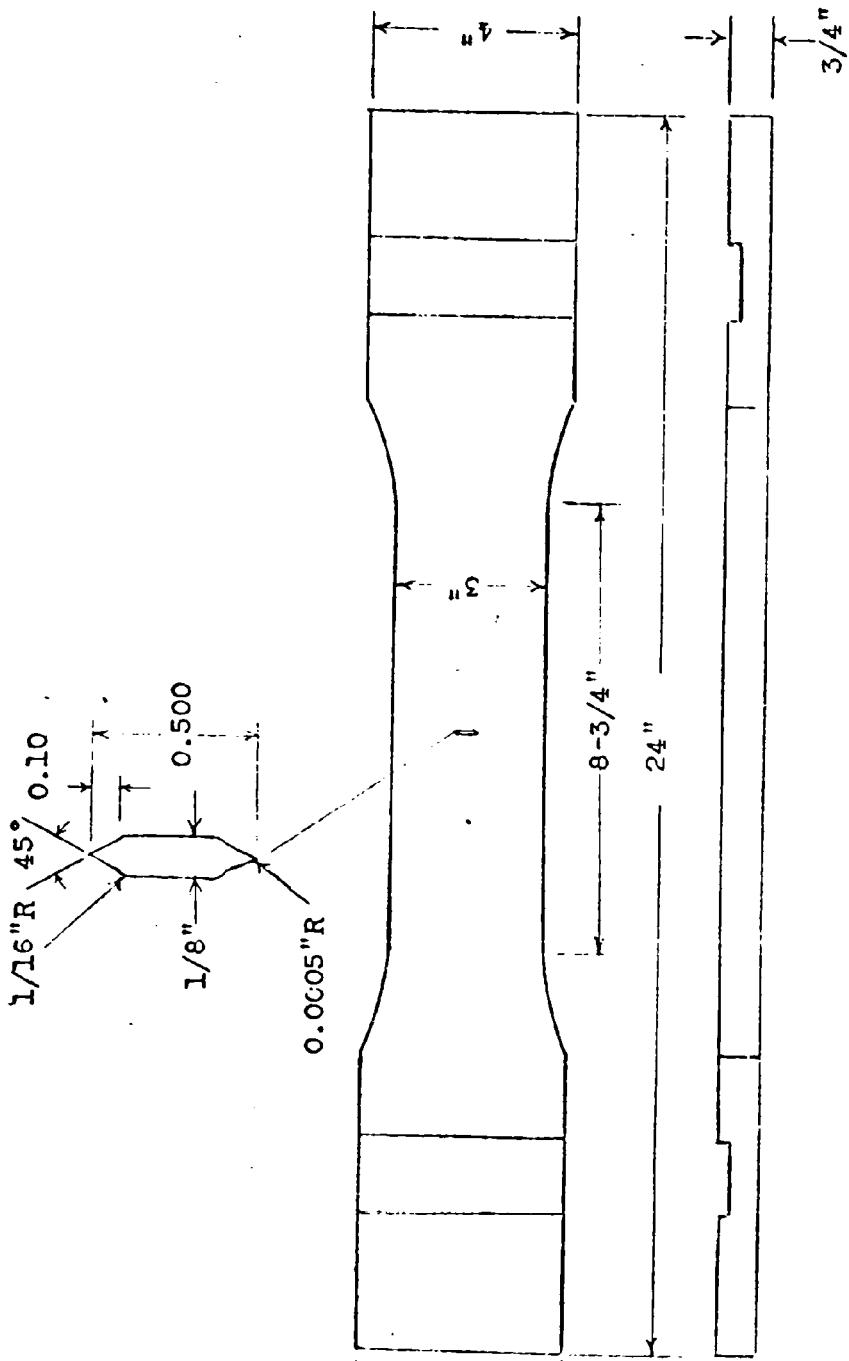
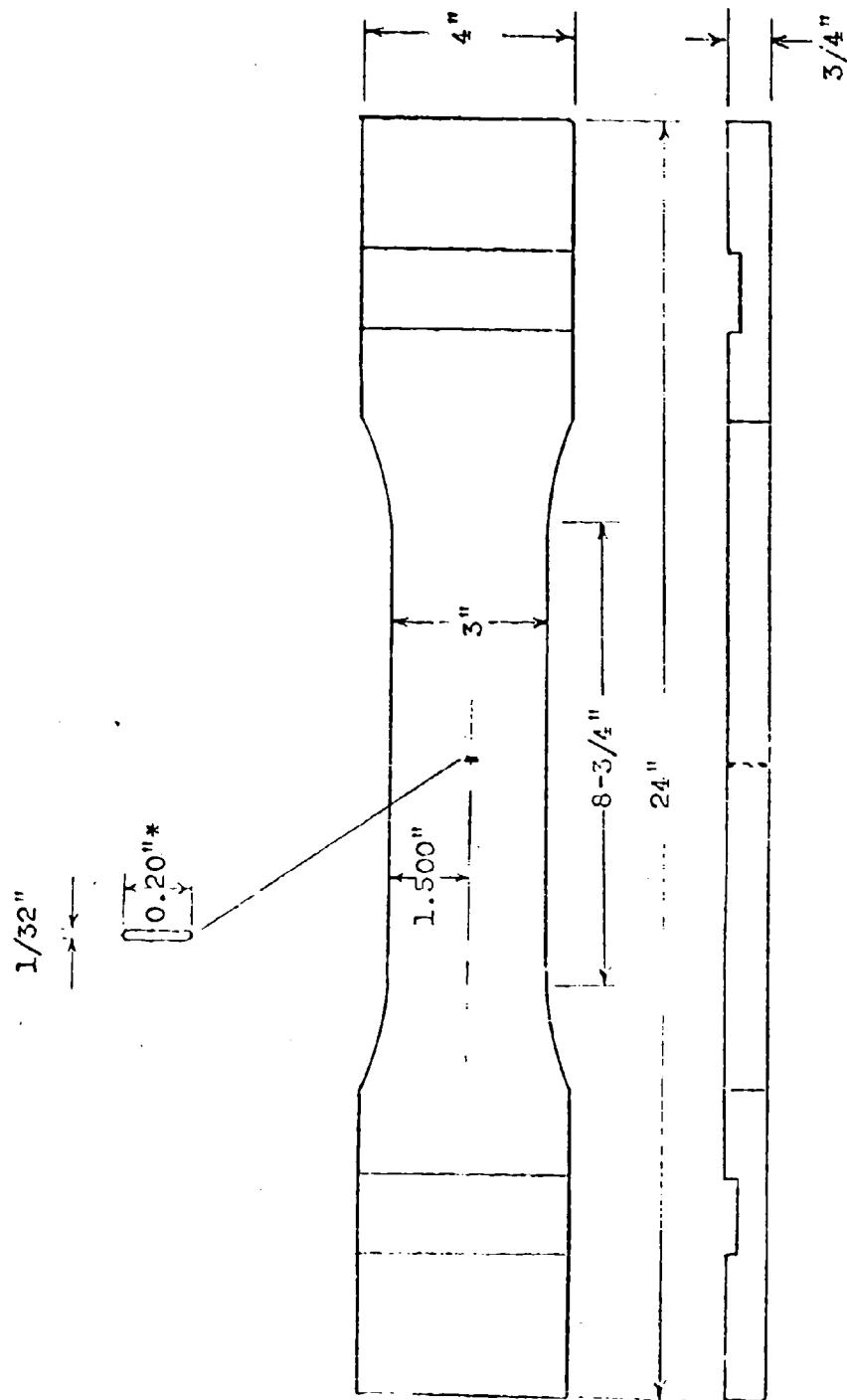


Fig. 21 Center-Notched Fatigue Specimen
(SHARP NOTCH)

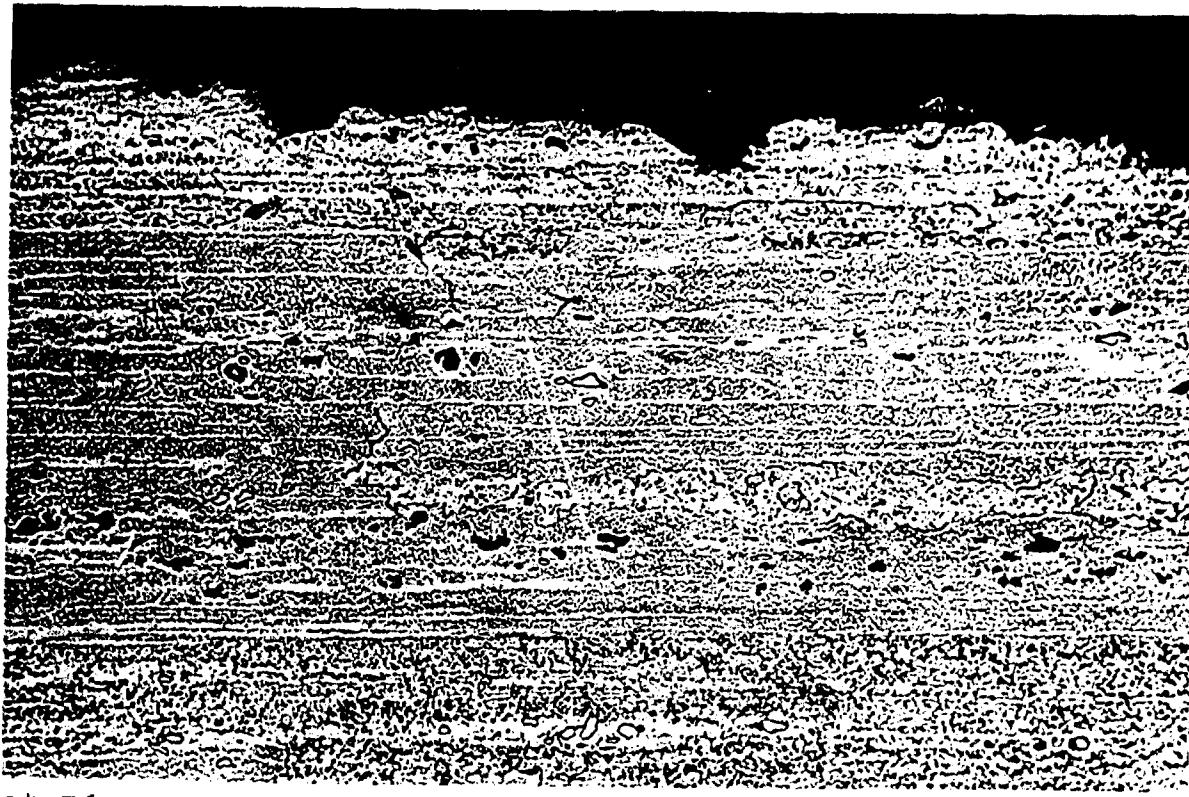
Fig. 21



*Specimen precracked to 0.50 in.

FIG. 22 Elox Notched Crack Propagation Specimen

Fig. 22



2014-T652 SPECIMEN 341016-7

Mag. 100X, Keller's Etch

a. Slow Propagation



2014-T652 SPECIMEN 341016-10

Mag. 100X, Keller's Etch

b. Fast Propagation

STRUCTURE IN THE SURFACE REGION OF FATIGUE CRACK PROPAGATION,
MAX. GROSS STRESS = 12.5 ksi

Fig. 23
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